



CUP₄SOIL

User requirements for a Copernicus Land Monitoring Service including soils

Fenny van Egmond², Uta Heiden¹, Thaïsa van der Woude², Pablo Angelo¹, Laura Poggio², Paul Karlshoefer¹

¹ DLR

² ISRIC

ESA SYMPOSIUM ON EARTH OBSERVATION FOR SOIL PROTECTION AND RESTORATION

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ISRIC
World Soil Information

Knowledge for Tomorrow



Introduction to the project - Objectives

Title:

High-resolution soil property service development for National and European soil carbon reporting

Timeline:

- Proposal submission in 2019, project approval in 2022
- 2-years project, **start Jan 2023**, ISRIC started in May 2023

Partner:

DLR and ISRIC



Funded by:

FPCUP - Framework Partnership Agreement on Copernicus User Uptake:
<https://www.copernicus-user-uptake.eu/>

Objectives

- Prepare a potential Copernicus downstream service to support national and European agencies for reporting on **soil health/quality**.
- Generate **European-wide example data products** characterising soil health/quality
- **Develop a user community** that tests and validates data products for soil health/quality information
- Ensure close **cooperation** with the ESA WorldSoils project activities and other related projects/initiatives such as the EJP SOIL projects and others etc. ...

Introduction to the project – Expected results

European-wide EO data products and soil maps (20 m pixel size):

- Soil property maps (e.g. soil organic carbon, soil texture) and
- Information about soil and vegetation dynamics including quality indicators – presented in a dedicated web page

Documents:

- (1) User requirements document tailored to the need of Copernicus Users
- (2) Key soil product description including robustness tests, product quality, feasibility for European-wide application
- (3) Showcases (example downstream applications)
- (4) Scientific and grey publications
- (5) User survey collecting feedback of the community (User requirements)

Meeting and Workshops:

- (1) Q4/2023 – Virtual meeting for discussing and consolidating User Requirements
7th December 2024 - online
- (2) Q1/2024 – First soil information products are presented, user requirements will be updated
6th – 7th March 2024 – during the ESA Symposium on EO for Soil Protection and Restoration
- (3) Q4/2024 – Final project workshop to assess key user feedback, recommendations and future directions
TBD

CUP₄SOIL – Welcome and Introduction

CUP₄SOIL Webpage



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CUP₄SOIL: High-resolution soil property service development for National and European soil carbon reporting

[Survey on requirements and wishes for future soil products provided by the Copernicus Land Monitoring Service \(CLMS\).](#)

This action aims at a downstream service to support national and European agencies for reporting on soil health/quality and thus, contribute to the Land Degradation Monitoring (LDN) and Sustainable Development Goal (SDG 15.3.1) reporting. It further underpins the pre-operational Soil Monitoring System currently being developed within the ESA WorldSoils project with the potential to serve as a component of the Copernicus Land Monitoring Service. Using synergies between this action and the ESA WorldSoils project will streamline the activities and boost the user uptake. The 2-year CUP₄SOIL project comprises the following objectives:

- Develop a potential Copernicus downstream service to support national and European agencies for reporting on **soil health/quality**.
- Generate **European-wide data products** and indicators characterising soil health/quality
- Prepare and **develop a user community** that tests and validates data products for soil health/quality information
- Ensure close **cooperation** with the ESA WorldSoils project activities and other related projects/initiatives such as the EJP soil project STEREOPEs, SERENA, etc.

Initiatives and literature: In the first step, CUP₄SOIL explores the different literature and project resources to get an update about the current discussion of essential soil health indicators. This will be collected in a first version of a User Requirement Document (URD) that CUP₄SOIL presents, discuss and adapt with a larger community during the first User Requirement virtual meeting. For this purpose, a specific online user survey will be developed based on the framework of the FPCUP requirements. The survey is

Source: <https://www.copernicus-user-uptake.eu/user-uptake/details/cup4soil-high-resolution-soil-property-service-development-for-national-and-european-soil-carbon-reporting-512>



Deutsches Zentrum für Luft- und Raumfahrt
German Aerospace Center



Point of contact
Uta Heiden
German Aerospace Center
Oberpfaffenhofen
82234 Wessling
Phone: +49-8153-283282
Mail: uta.heiden@dlr.de
URL: www.dlr.de/eoc

Implementing Partner: DLR
Implementing Country: Germany
Primary Topic: Land
Primary Target Users: Public Sector, Research Sector
Primary Target Region: Europe
Type of Action: Developing and piloting downstream applications and services
Action No.: 2020-2-14
Duration: Apr 2022 - Apr 2025 **Last Update:** 20 Oct 2023



User Requirement study - First findings



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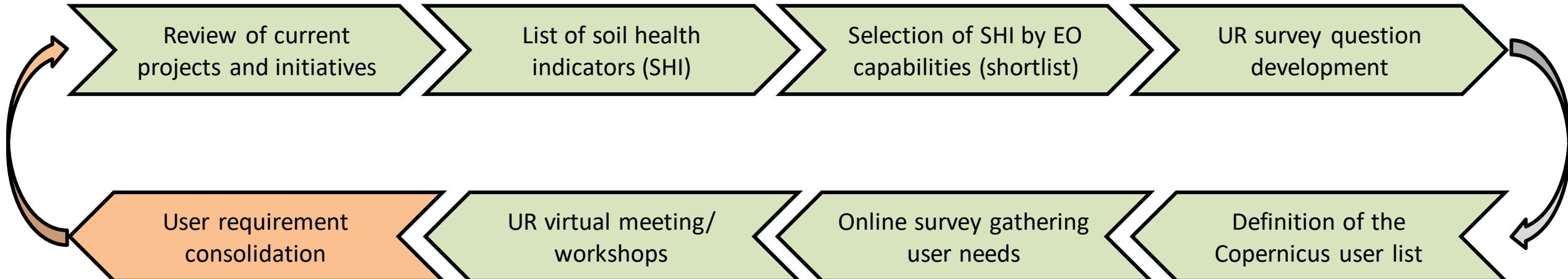


Knowledge for Tomorrow

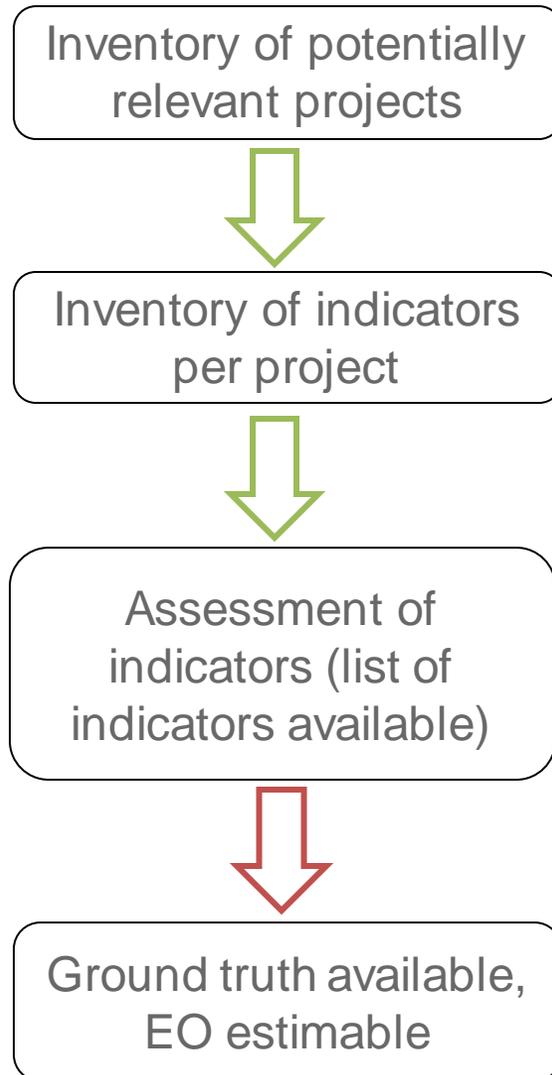
User requirements

Iterative process:

- Reviewing existing projects and initiatives
- User requirement survey
- User requirement meeting
- Feedback from case study results



User requirements from existing projects / initiatives



- EJP SOIL (SIREN, SERENA, MINOTAUR, WP6, STEROPES)
- WorldSoils
- EEA level₁
- LUCAS
- MARVIC, MRV₄SOC
- ENVASSO
- EU Soil Monitoring Directive
- Status of the World's Soil Resources (GSP)
- LANDMARK
- ISQaPer
- RECARE
- BENCHMARKS, AI₄SoilHealth
- PREPSOIL
- Etc.

User Survey - Development

- A survey was launched to understand more about the specifications of the spatial information
- 23 questions
- Sent out to people across Europe on soils and EO
- Ongoing until the ESA Symposium on EO for Soil Protection and Restoration (06-07 March 2024)
- Results presented here and in report
- Presentation of the status of the 25th of February 2024

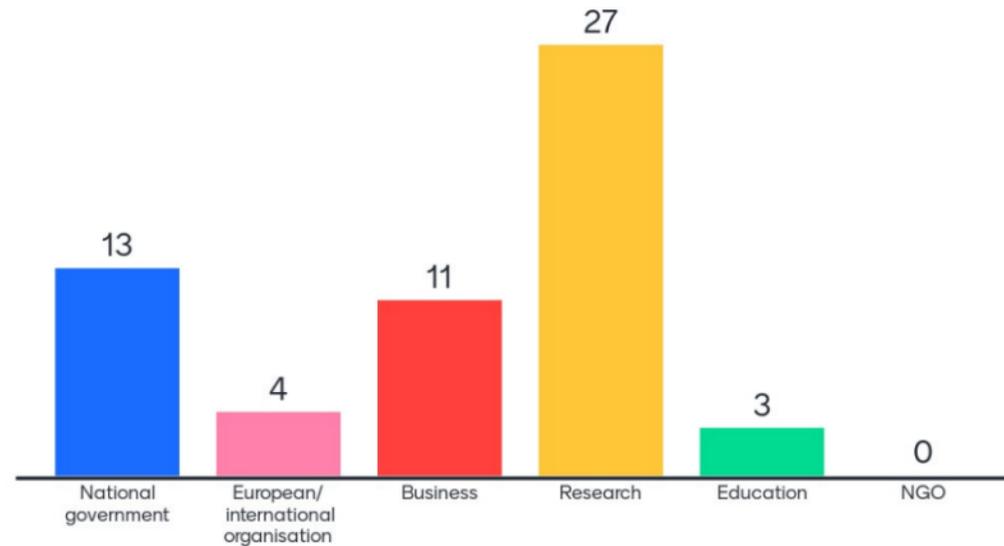
User requirements survey for a future Copernicus Land Monitoring Service on soils



User Requirement Meeting

- 2 hour workshop on 7 December 2023
- 148 registered participants - 80 real participants

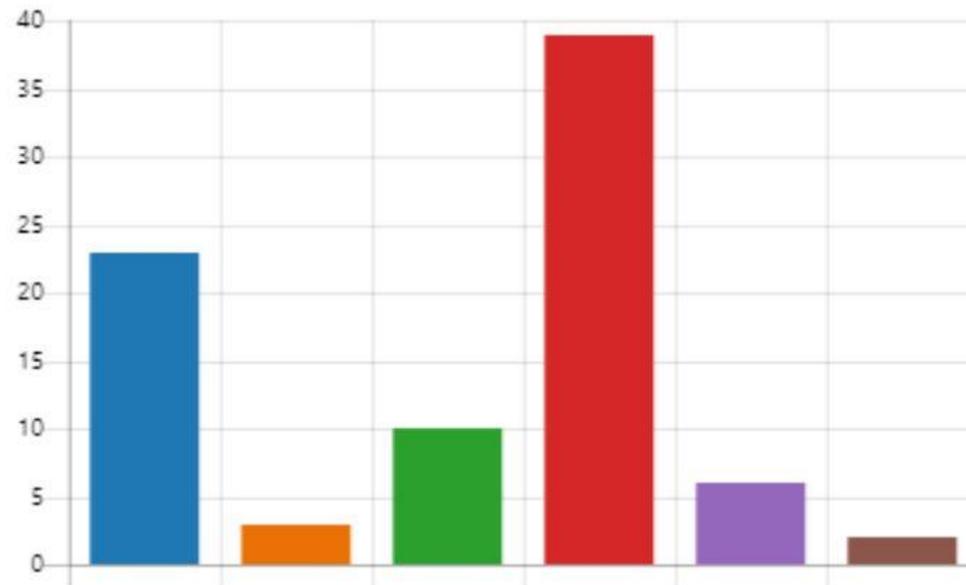
What best describes your organisation?



User survey

2. What best describes your organization?

| | |
|--|----|
|  National government | 23 |
|  European / international orga... | 3 |
|  Business | 10 |
|  Research | 39 |
|  Education | 6 |
|  NGO | 2 |



83 responses so far

Partitioning across sectors is quite similar to the workshop participation partitioning

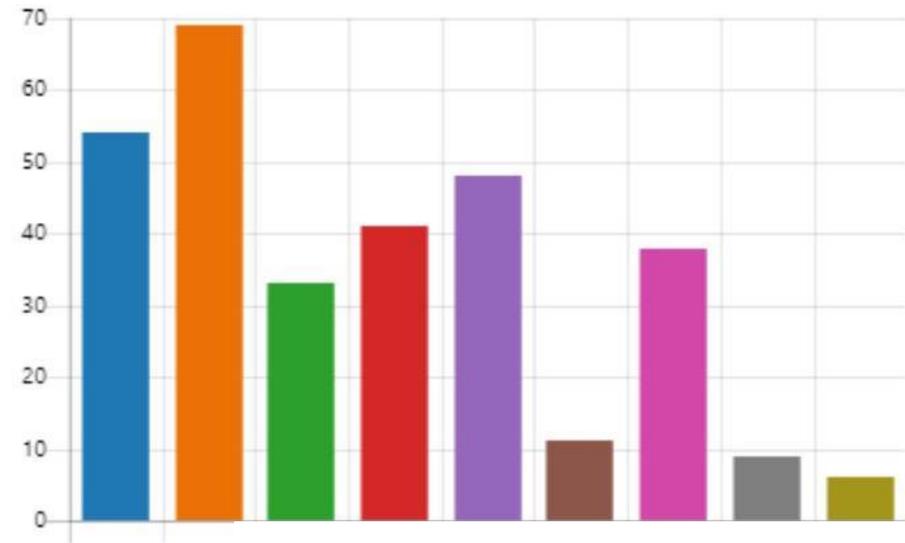
Majority of participants from Europe, also some from all other continents

CUP4SOIL – User Requirement Study

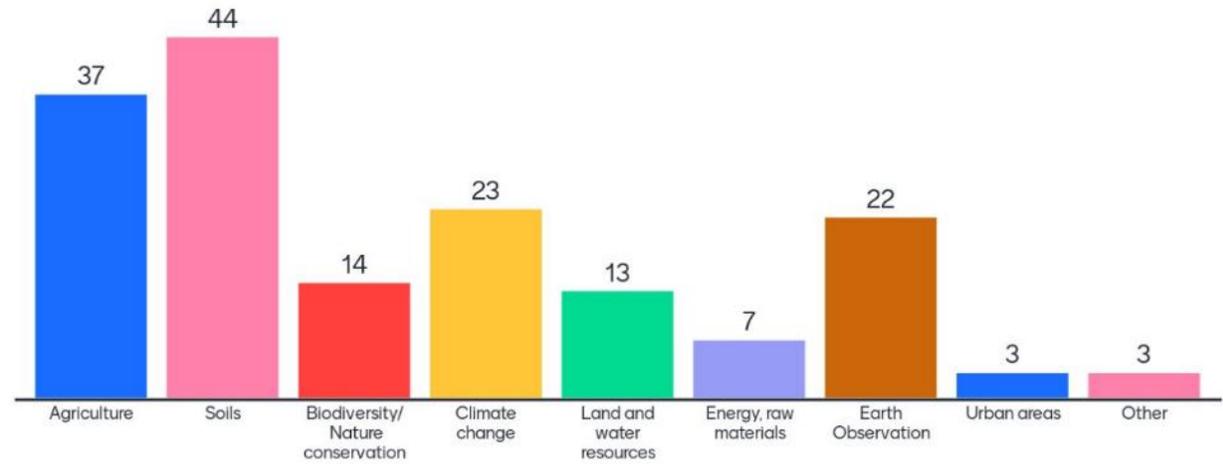
User Survey - Workshop

What are the main topics your organisation is working on?

| | |
|--|----|
| ● Agriculture | 54 |
| ● Soils | 69 |
| ● Biodiversity / Nature conserva... | 33 |
| ● Climate Change | 41 |
| ● Land and water resources | 48 |
| ● Energy, raw materials | 11 |
| ● Earth Observation | 38 |
| ● Urban areas | 9 |
| ● Other | 6 |



Same top four

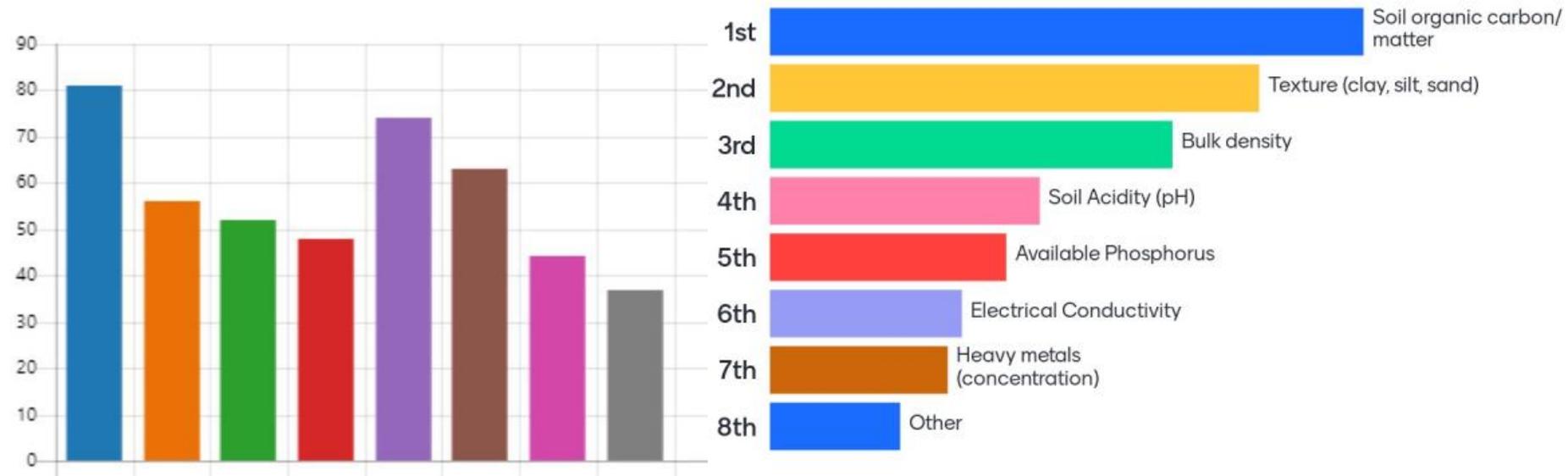


CUP₄SOIL – User Requirement Study

User Survey – Workshop

Which soil-related spatial information would be helpful for your work (basic soil properties)?

| | |
|------------------------------------|----|
| Soil organic carbon / Soil orga... | 81 |
| Soil acidity (pH) | 56 |
| Total Nitrogen | 52 |
| Phosphorus available | 48 |
| Texture (clay, silt, sand content) | 74 |
| Bulk density | 63 |
| Electrical Conductivity (EC) | 44 |
| Heavy metals (concentration) | 37 |
| None of them | 0 |

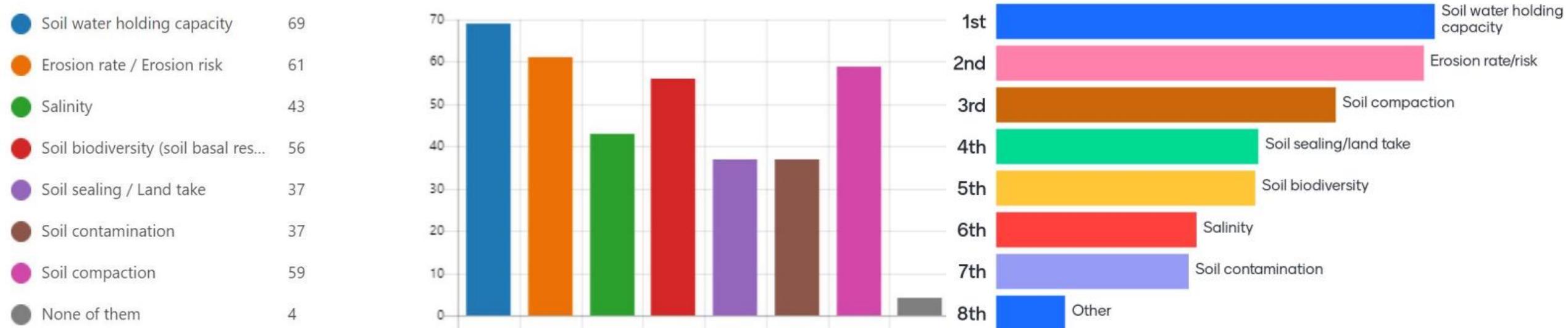


Same prioritisation

CUP₄SOIL – User Requirement Study

User Survey – Workshop

Which soil-related spatial information would be helpful for your work (derived/complex properties)?



Same top three

User Survey – Familiarity with Copernicus

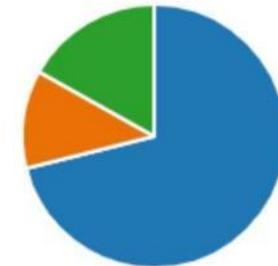
4. Do you know about the Copernicus Land Monitoring service?

| | |
|-------|----|
| ● Yes | 66 |
| ● No | 17 |



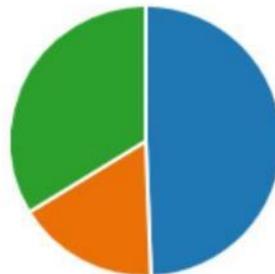
6. Have you used Copernicus Earth Observation data (e.g. Sentinel missions, Contributing mission) before?

| | |
|--------------------------------------|----|
| ● Yes | 59 |
| ● No | 10 |
| ● No, but I would like to learn m... | 14 |



5. Have you used the Copernicus Land Monitoring service before?

| | |
|----------------------------------|----|
| ● Yes | 41 |
| ● Yes, but it is a long time ago | 14 |
| ● No | 28 |



7. Have you used Copernicus in-situ data before?

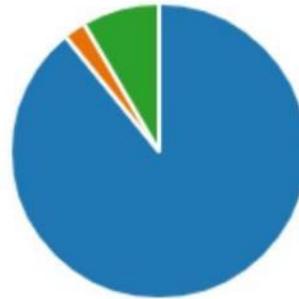
| | |
|--------------------------------------|----|
| ● Yes | 19 |
| ● No | 32 |
| ● No, but I would like to learn m... | 32 |



User Survey – Familiarity with Copernicus

8. Does soil health and/or soil quality fall into your area of expertise?

| | |
|------------------------------------|----|
| Yes | 74 |
| No | 2 |
| No, but I would like to learn m... | 7 |



9. Are you missing soil-related information at the Copernicus Land Monitoring Service?

| | |
|-------|----|
| Yes | 54 |
| No | 2 |
| Maybe | 27 |



10. How would you rate the use(fulness) of future soil products under the Copernicus land monitoring service?

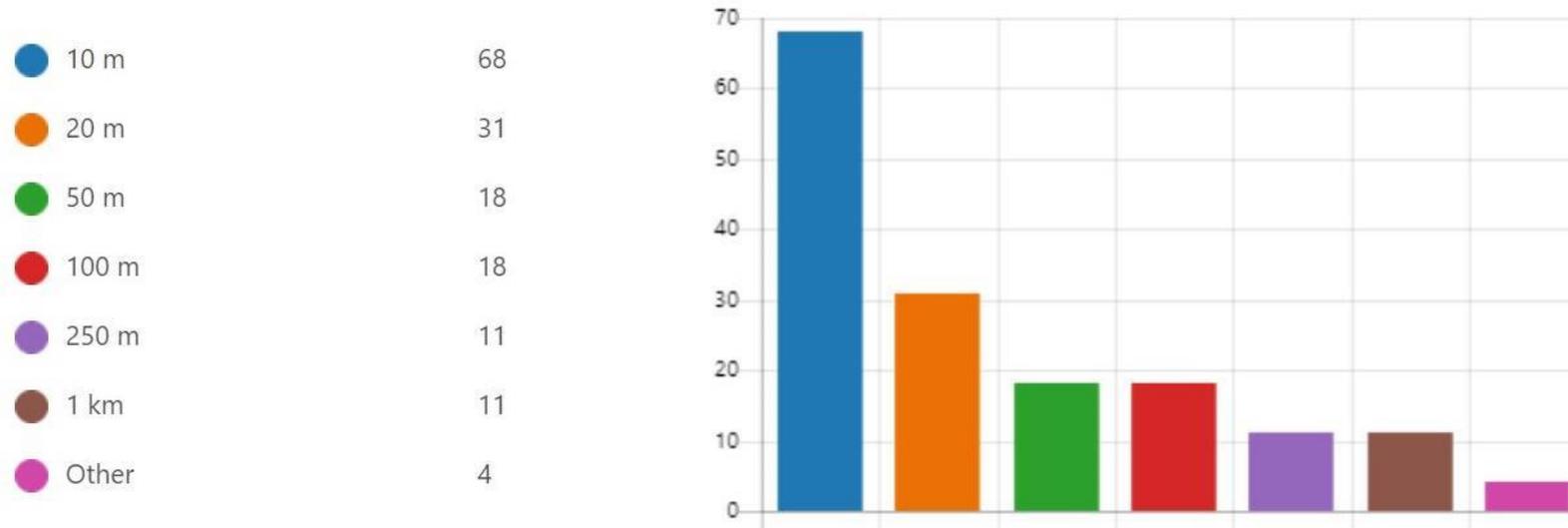
| | |
|-----------------------------------|----|
| Very useful, regardless how th... | 34 |
| Depends on the products | 47 |
| I will not use it | 2 |



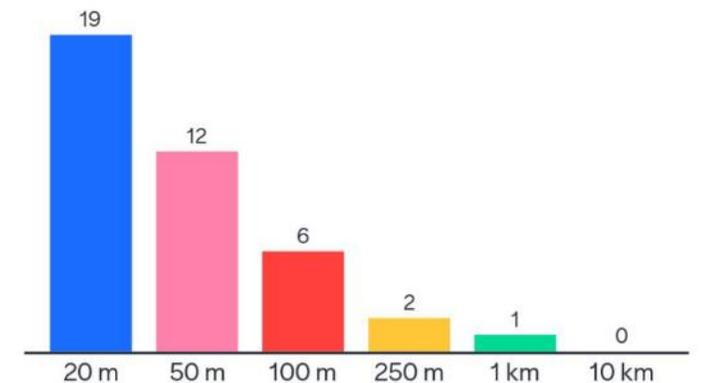
CUP4SOIL – User Requirement Study

User Survey – Resolution

What is your preferred spatial resolution you are working on (in pixel sizes)?

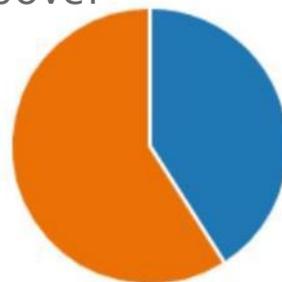


Finer resolutions are always desirable, but what are the coarsest resolutions that would still work for your use? (with accuracy matching resolution)



What accuracy level is still useful/required for your application given the specifications above?

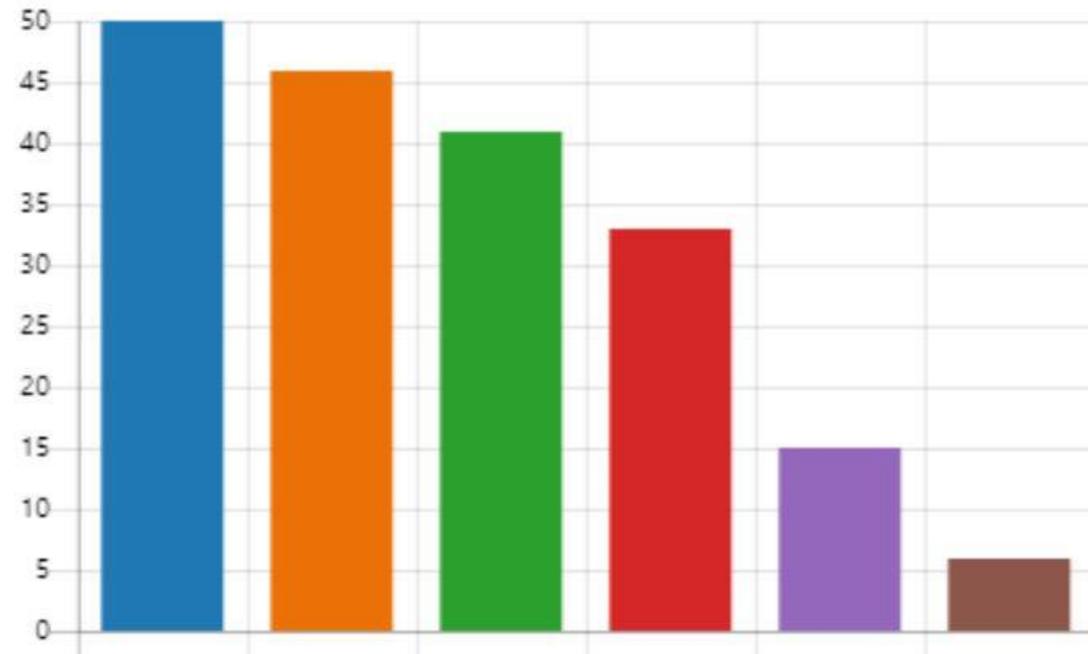
- Spatial pattern should make sense, no absolute accuracy necessary 34
- Correct quantitative values necessary 49



User Survey – Resolution

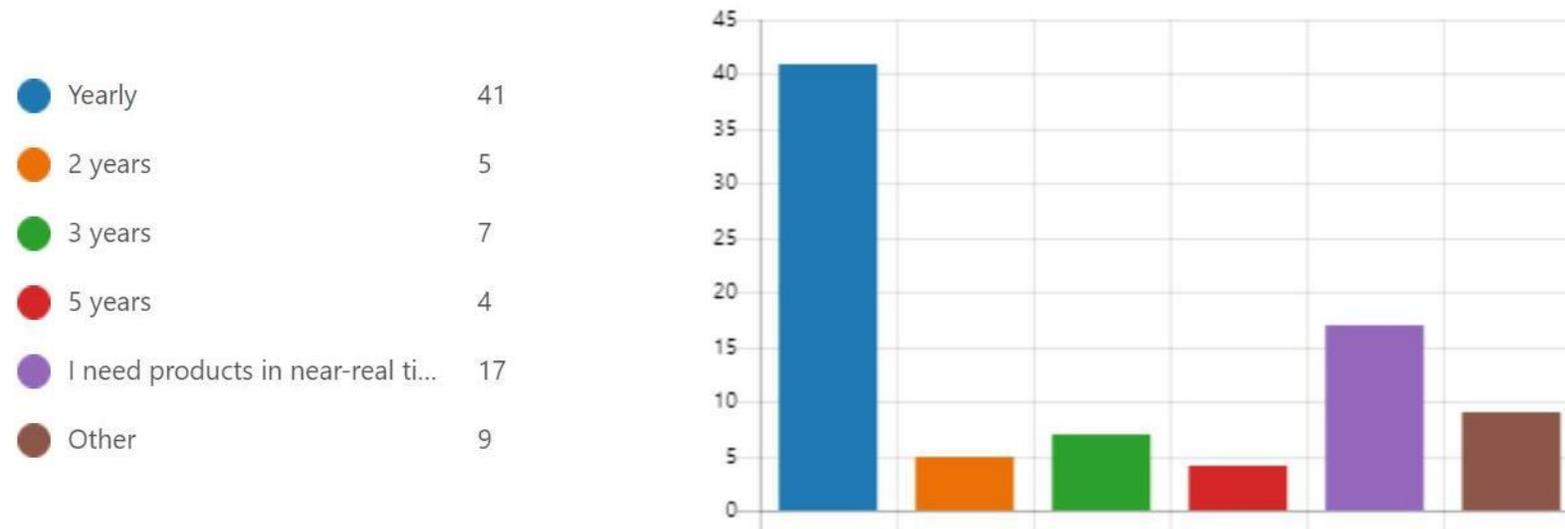
17. Which scale is your organization working on?

| | |
|-----------------------------------|----|
| ● One or several fields | 50 |
| ● Landscape/watershed/soil hea... | 46 |
| ● Subnational regions | 41 |
| ● Countries | 33 |
| ● Europe | 15 |
| ● Other | 6 |

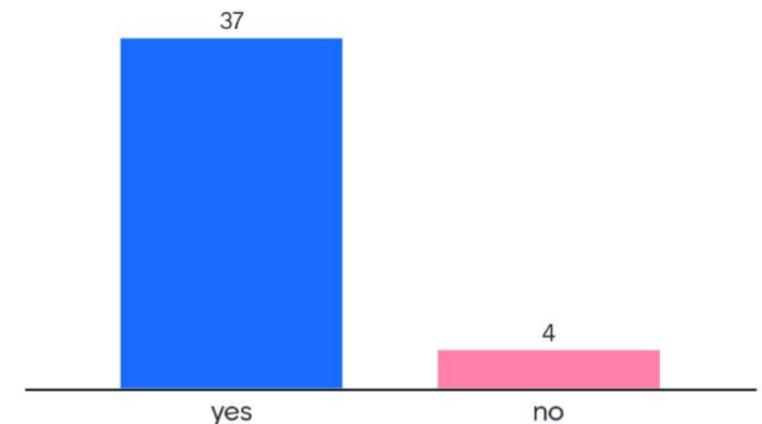


User Survey – Update frequency

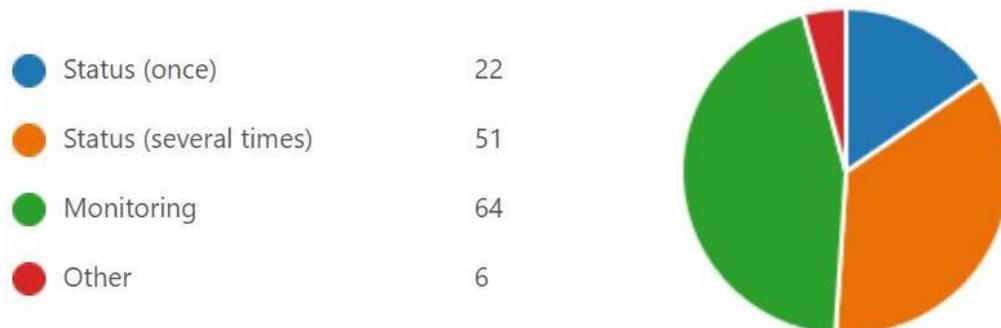
How regularly would you like to get updates on the soil service products?



If it is not feasible or meaningful to make yearly or near-real time updates to the products, is a longer (5/10 years) update period still useful?

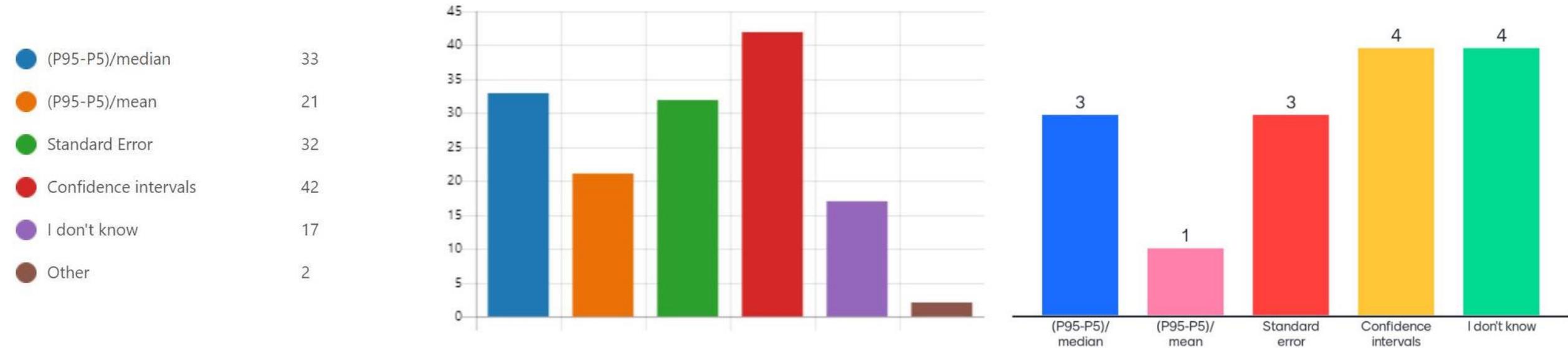


14. For which purpose do you need the soil information?



User Survey – Uncertainty measure

What is the uncertainty measure you would expect for the soil property maps?

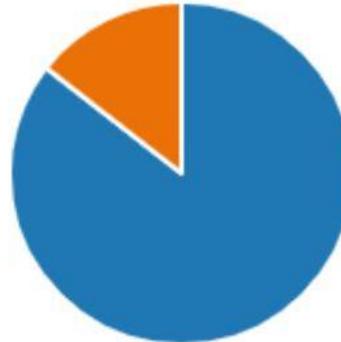


Same top three

User Survey – Access and data format

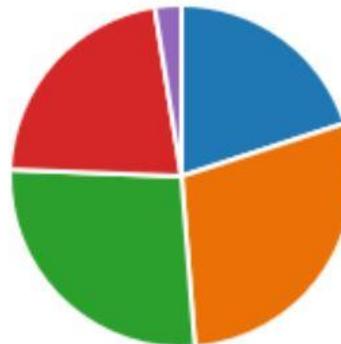
20. What would be your preferred data format?

| | |
|-------------------------|----|
| Cloud-optimised GEOTIFF | 77 |
| Other | 13 |

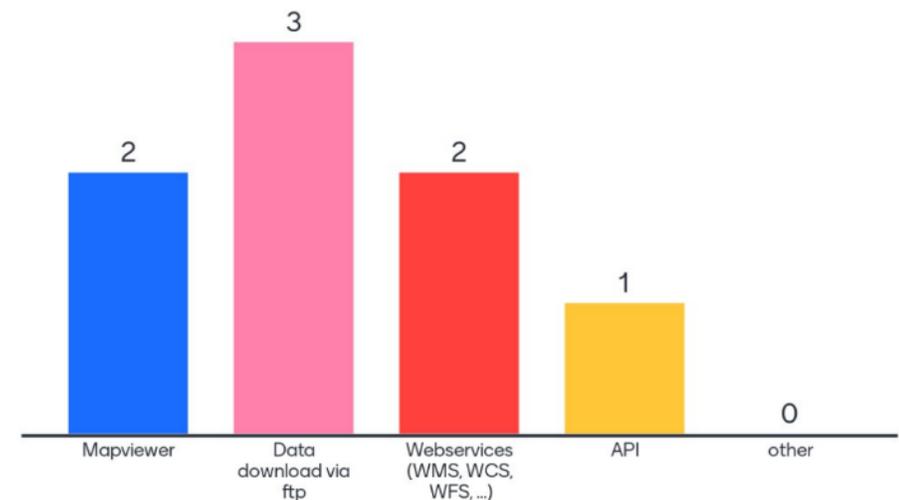


21. What would be your preferred access?

| | |
|------------------------------|----|
| Mapviewer | 32 |
| Data download via ftp | 46 |
| Webservices (WMS, WCS, WP... | 43 |
| API | 35 |
| Other | 4 |



What would be your preferred access?

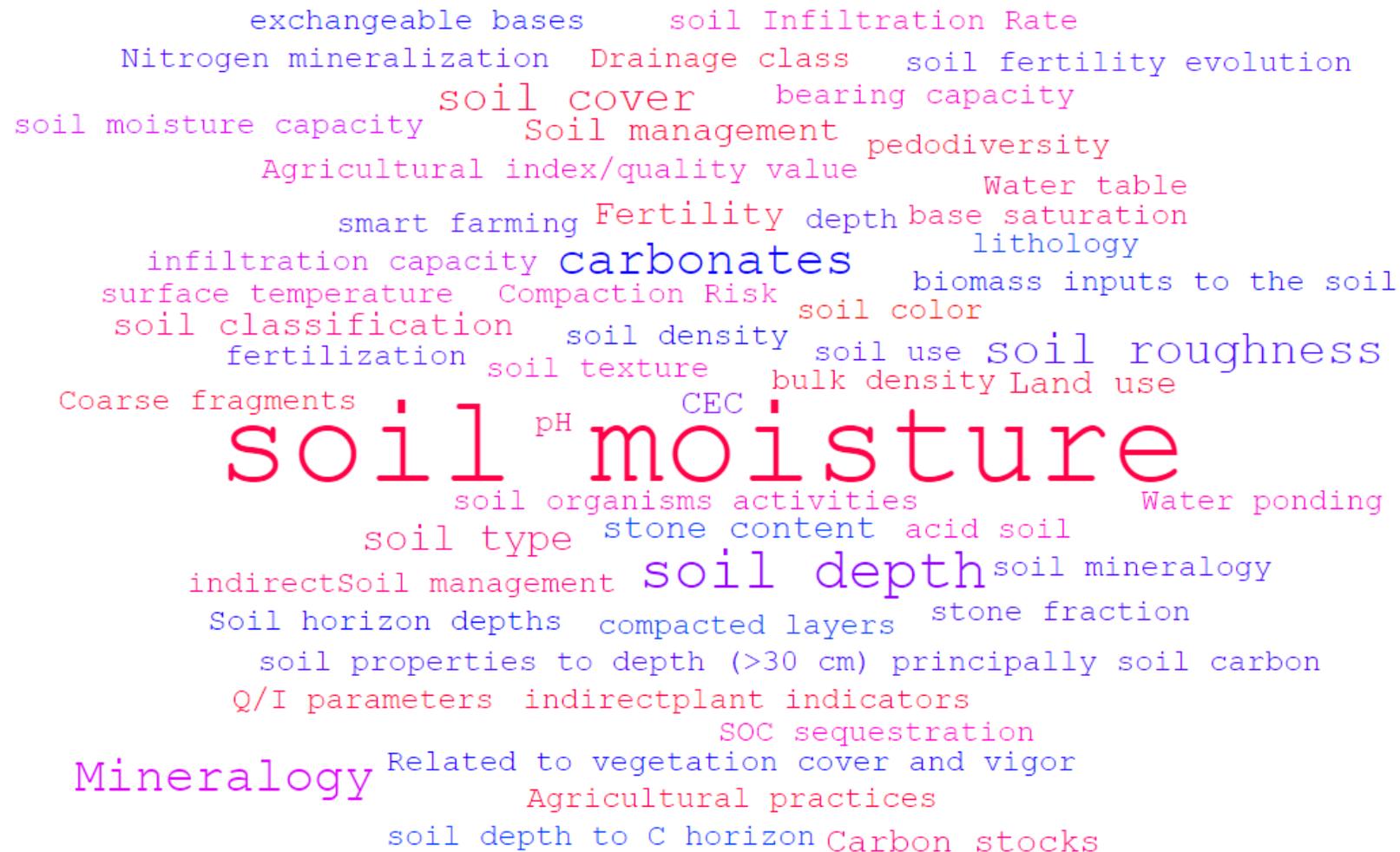


CUP₄SOIL – User Requirement Study

User Survey - Results



Which soil-related spatial information is not listed before?



CUP₄SOIL – User Requirement Study

User Survey – Results



- Further comments (selection):

I would love to learn more information about Copernicus land monitoring service related to subject **smart farming and precision agriculture** learning

The processed raster data have to be **adequately validated!** We see an extreme discrepancy between millions of pixel and only some thousands of ground truthing data. The processed raster data is only so good as it can be correctly validated.

Standardization of soil data and soil description is urgently necessary also for the harmonized EU market. For a company it is very difficult to adapt its software / products to every federal legislation like here in Germany and therefore to develop products for the . And if the EU is not doing it it will be only the national level , which will help us companies not a bit.

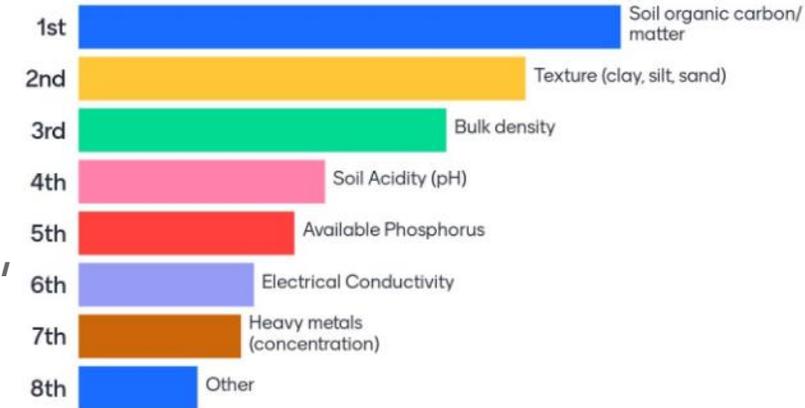
As user, indeed...this tool for landscape data analysis really needed especially for our research students and project for soil pollution, management of lands quality and health. Thanks in advance. 👍

"we need better information on the **endowment of agricultural landscapes with semi-natural landscape features**. Thanks for your work and effort!"

It doesn't make sense to provide only the data. **The underlying method should be described in detail**. A measure for the accuracy is helpful (such as confidence intervals) and the underlying method should be validated with measured field data.

User Survey – Summary of the results

- Up to half of the answers are from the **Research** sector
- Copernicus products are well known and used (59/83), in situ products less (19/83), Land Monitoring Service is well known (61/83), but less recently used (41/83)
- 54 / 83 users are **missing** soil related information at the Copernicus service
- Most wanted **soil products** are:
 - SOC, texture and bulk density, soil water holding capacity, erosion, soil compaction, pH, soil biodiversity
- Soil moisture, soil depth, carbonates, mineralogy
- Spatial patterns are useful but quantitative correct values are more important
- Majority needs information for **monitoring yearly**, but if not possible **less often is still useful**. Purposes are MRV, monitoring, CAP
- Spatial resolution winner is **10-20 m pixel size**, but **coarser pixel sizes are still useful**
- **Various ways of access to cloud-optimised geotiff's** is desirable



User stories

As an **<actor>**,
I want to have/be able to **<function>**,
so that I can/don't have to **<business reason>**.

As a **company** that gives a economic rewards to farmers who try to increase the **carbon content**, we want to be able to track changes in the soil carbon content to **reduce sampling costs**.

As a **paying agency officer**,
I want to have soil erosion layer for **CAP compliance** at field level of 10 meter resolution.

As a **sustainable water management company**, I want to provide accurate water balance information at a parcel scale, so that farmers can manage water usage in a sustainable way for **irrigation**.

As a **government agency** we want to **evaluate our own soil** (property) **maps**. We are satisfied with a 50 m resolution (field scale).

As an **ag-tech company**, I want to be able to use soil texture and SOM to generate **seeding maps**.
So, a good data layer for the farmers. I'm satisfied when the accuracy is 0.5% (SOM) at 10 m.

As a **researcher**, I want to predict SOC to be used for providing maps and plans for farmers at **regional and national level** in cooperation with governments. I'm satisfied with 20 m resolution and 10% error

The **resolution** is not so much the question, the question is how valid, how **accurate** is the model.

Next actions

- User requirements report, including all presented results
- Survey continues
- ...



CUP₄SOIL

Thank you very much!



Contact: uta.heiden@dlr.de (DLR)
fenny.vanegmond@wur.nl (ISRIC)
Laura.poggio@wur.nl (ISRIC)

User Requirement Survey



CUP₄SOIL Webpage



Photo: Uta Heiden

Discussion questions

- Accuracy versus resolution? What is good enough for which purpose?
- What is useful/feasible in update frequency?
- Which user stories/applications are we missing?

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Mentimeter

What best describes your organisation?



-
- National government
 - European/ international organisation
 - Business
 - Research
 - Education
 - NGO





DLR

CUP₄SOIL - Thank you very much!

Contact: [email]



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Photo: Uta Heiden