

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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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

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. ...

Partner:

DLR and ISRIC

Funded by:

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



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

User Requirement study - First findings



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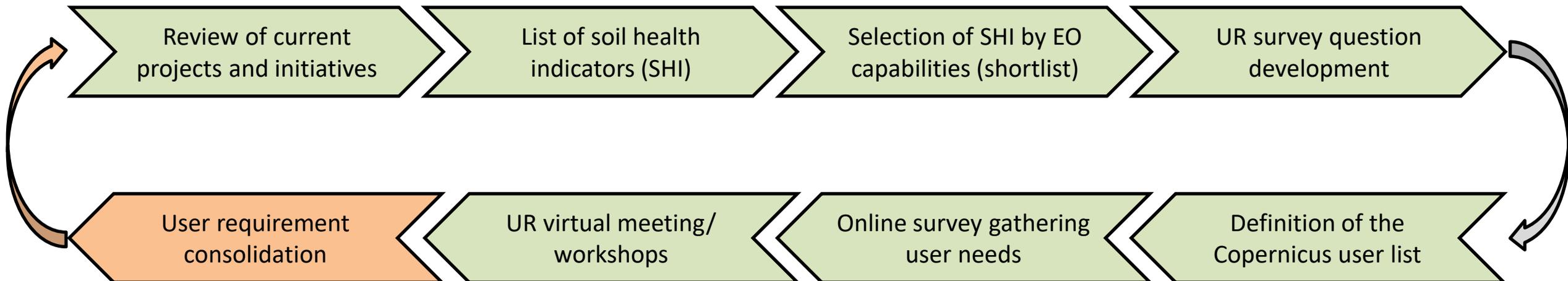
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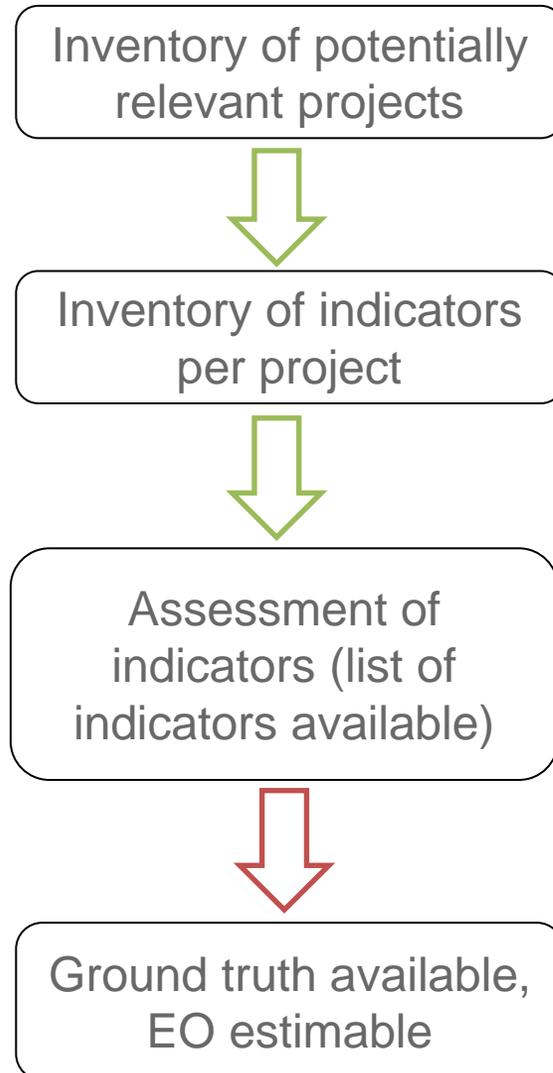
User requirements

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.

Shortlist ...



- When listed more than 4 times in the mentioned projects, the indicator is selected:
- Simple properties: Soil Organic Carbon (SOC), Soil Organic Matter (SOM), pH, Total Nitrogen (N), available Phosphorus (P), soil texture (clay, silt, sand), bulk density, Electrical Conductivity (EC), heavy metals (concentration)
- Complex (derived) properties: available water capacity, erosion, salinity, soil respiration, earthworms, soil biodiversity (can contain soil respiration and earthworms but not necessarily), soil sealing, soil contamination, compaction
- These 18 soil indicators have been evaluated against:

- The NextSpace Copernicus User requirements for soil in 2019 (8/19)

- EJP SOIL-SIREN (12/14)

- Mission ‘A Soil Deal for Europe’ (8/13)

- Proposed EU Soil Monitoring Directive (16/18)

	NextSpace Copernicus User Requirements (Soil) 2019 https://www.copernicus.eu/en/documentation/studies-and-surveys	Shortlist "minimum dataset" suggested by EJP/SIREN project	A soil deal for Europe - Implementation plan 202x	Soil Health Law July 2023	BENCHMARKS/A4SoilHealth
	Latest known Copernicus user requirement study	The EJP SOIL program is the scientific forefront in Europe dealing with a sustainable European integrated research system and develop and deploy a reference framework on climate-smart, sustainable agricultural soil management. This is a reduced list based on an extensive review of literature, EU policies, requirements from member states and EU projects.	Implementation plan of the EC to achieve 100% healthy soils in 2050	Legal framework for the development of healthy soils	The project aims at providing a clear soil health index for benchmarking, using indicators that are pertinent to the objective of assessment, applicable to the land use and logistically feasible.
Reason for selection	Soil fertility Soil carbon content Soil Surface Vertical Roughness Geological Maps Land Use/cover, Topography/ Soil Moisture Soil erosion risk maps Soil erosion change risk maps Vegetation condition factor Soil type - Landcover map Volumetric Soil Moisture (SM) Soil carbon emissions and removal Soil texture Soil Degradation Soil Nutrient Content Soil function Impediments Soil Moisture Map - Animates Soil Temperature Texture Porosity Bulk density C concentration Total N P K pH Erosion Salinity Heavy metals Other contaminants Soil biodiversity Water repellition Presence of pollutants across nutrients Soils Soil organic carbon stock Soil function bulk density soil sealing erosion Soil biodiversity Soil nutrients and acidity (pH) Vegetation cover Landscape heterogeneity Forest cover SOC pH Soil Nutrient Availability Extractable P texture Bulk density Available water capacity erosion Soil function Soil conductivity Soil cover respiration Loss of soil biodiversity Total artificial land Land take Soil Sealing heavy metals Soil contamination Compaction				
Soil health indicators/parameters (24) from the currently running soil projects					
Simple properties					
SOM					
SOC	x		x		
pH	x				
Total N	x		x		
P available	x		x		
Texture	x			x	
Bulk density		x			
EC					
heavy metals					x
Complex or derived properties					
available water capacity				x	
erosion	x x x x x x x			x	
salinity					
Soil respiration			x		x
Earthworms					
Soil Biodiversity			x		x
Soil Sealing					x
Soil contamination			x		x
Compaction					x

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 February/March 2024

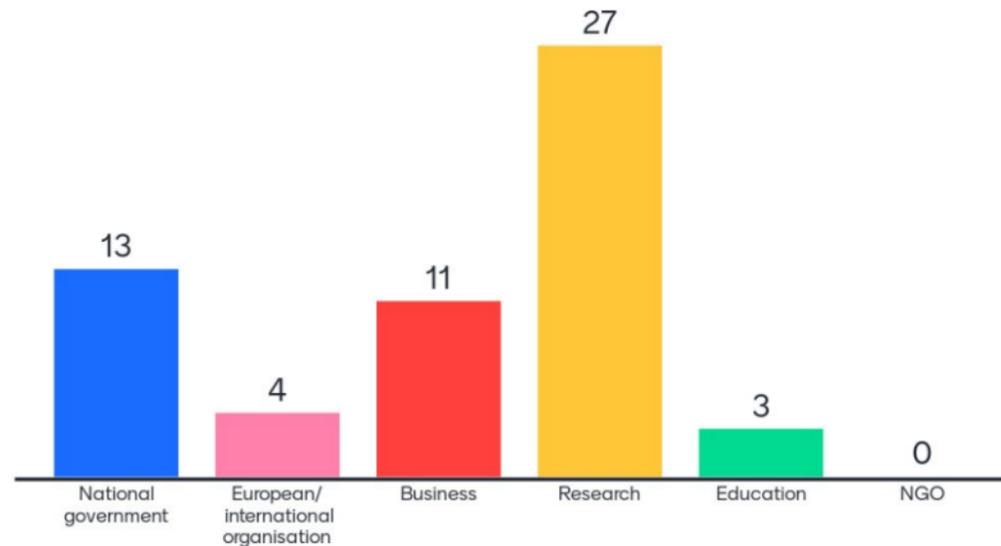
User requirements survey for a future Copernicus Land Monitoring Service on soils



User Requirement Meeting

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

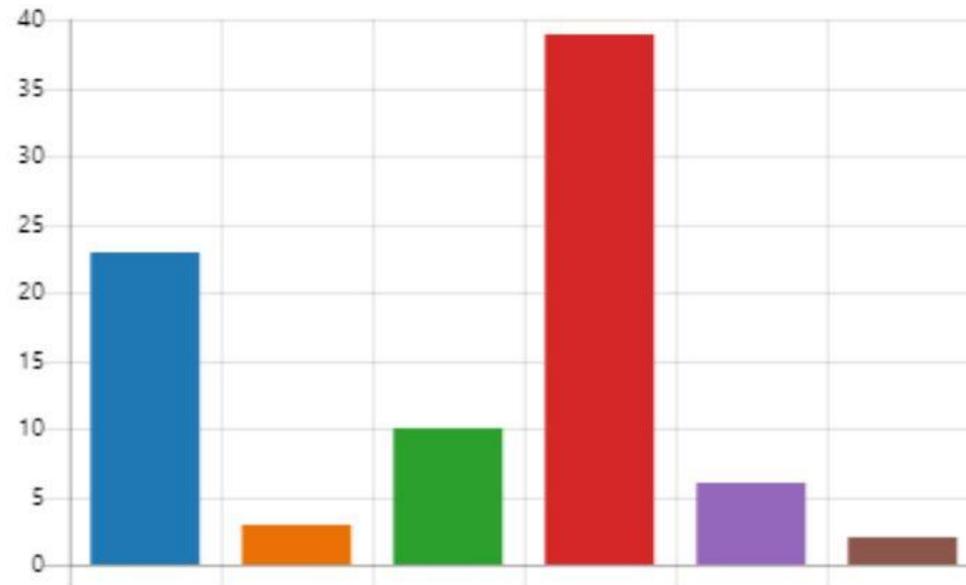
What best describes your organisation?



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

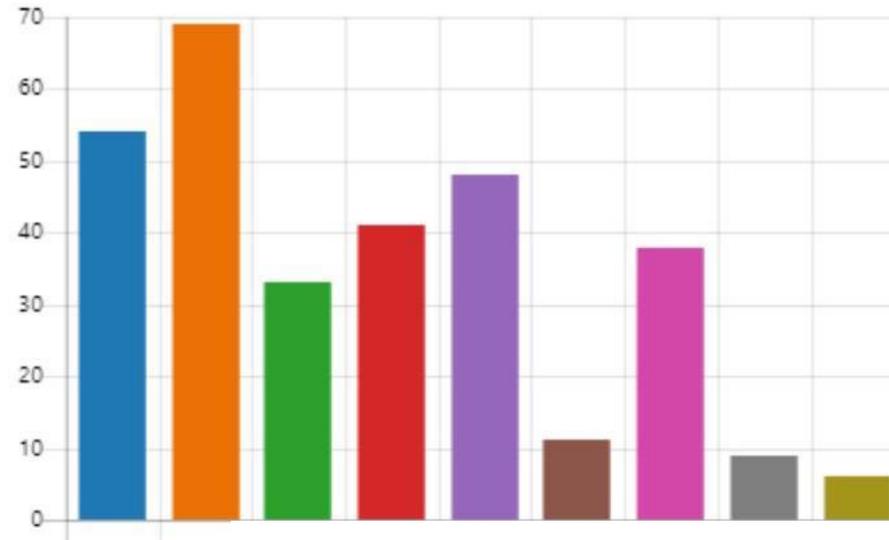
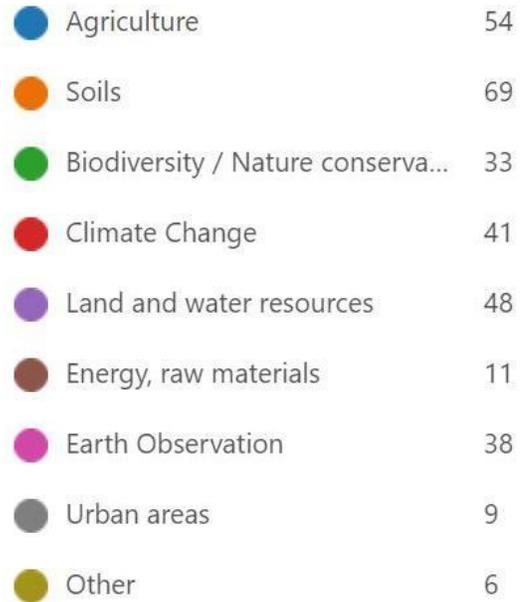
Partitioning across sectors is quite similar to the workshop participation partitioning

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

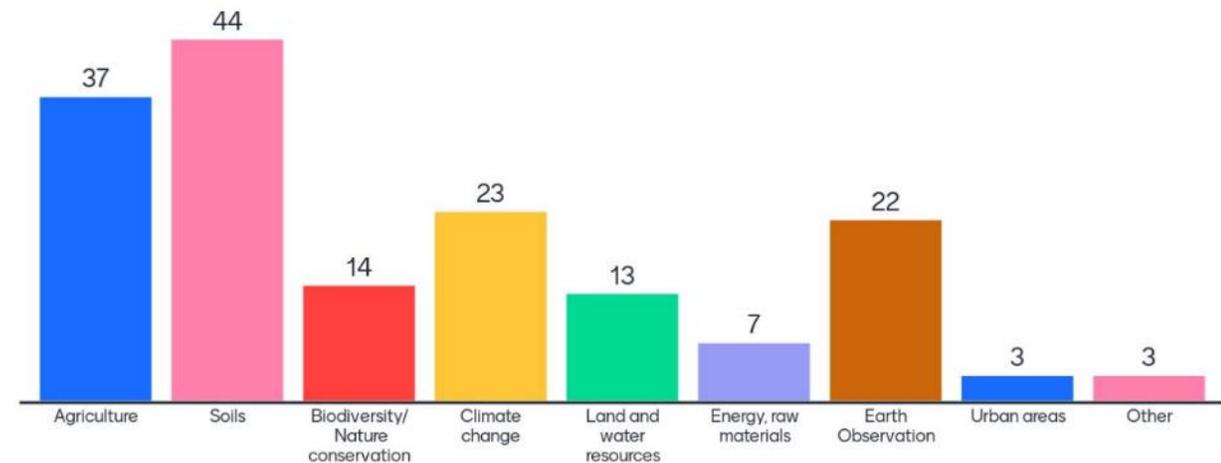
CUP₄SOIL – User Requirement Study

User Survey - Workshop

What are the main topics your organisation is working on?



Same top four

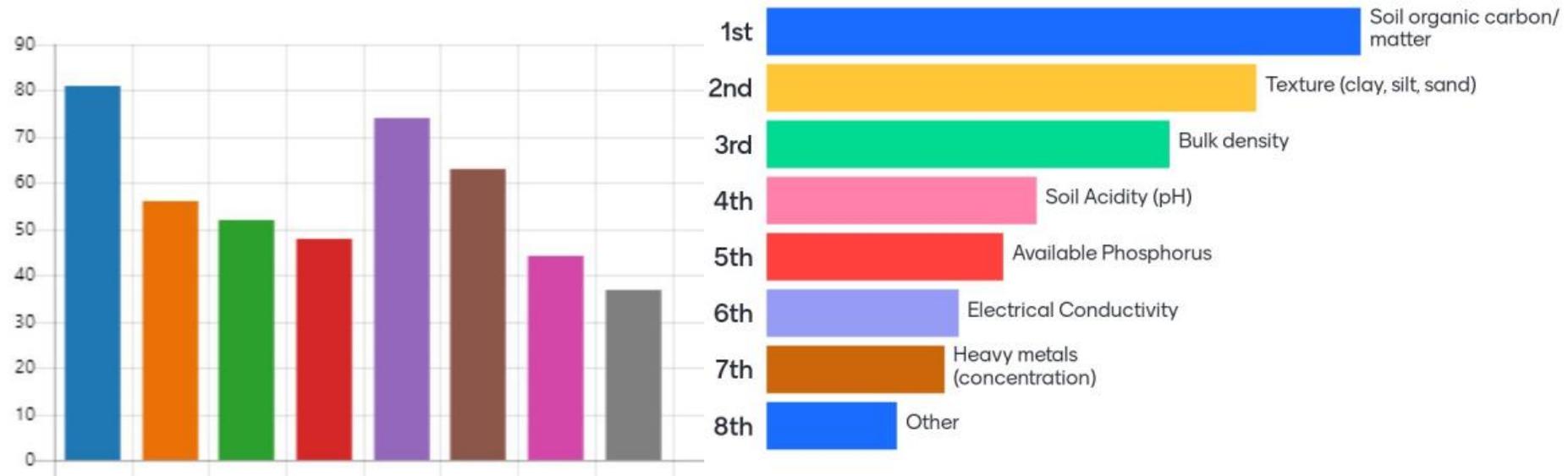


CUP4SOIL – User Requirement Study

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

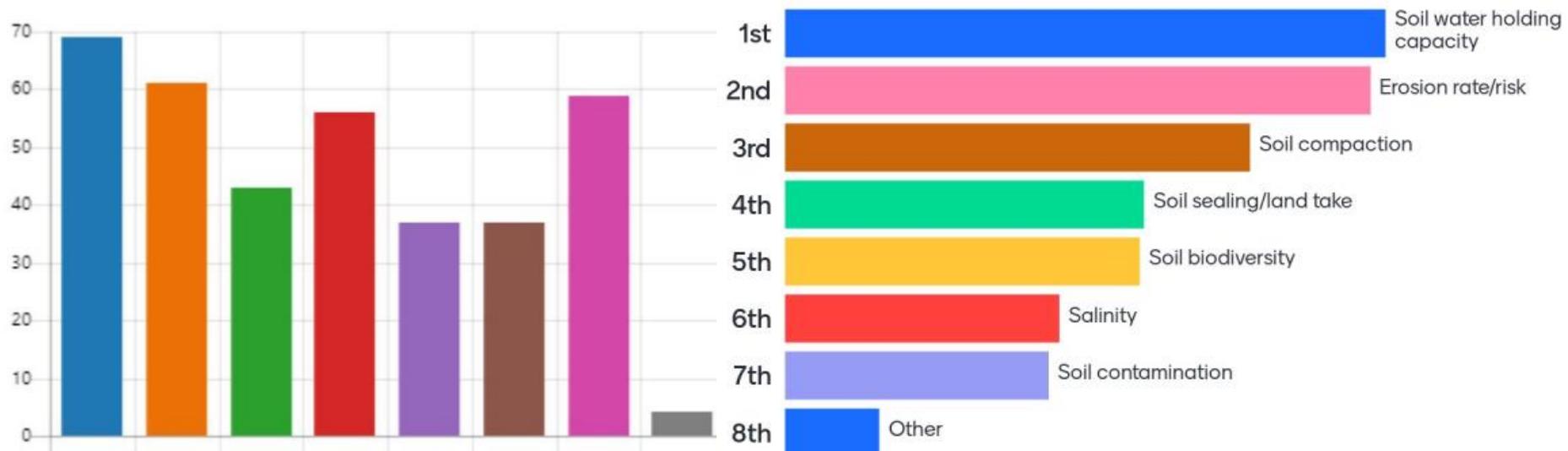
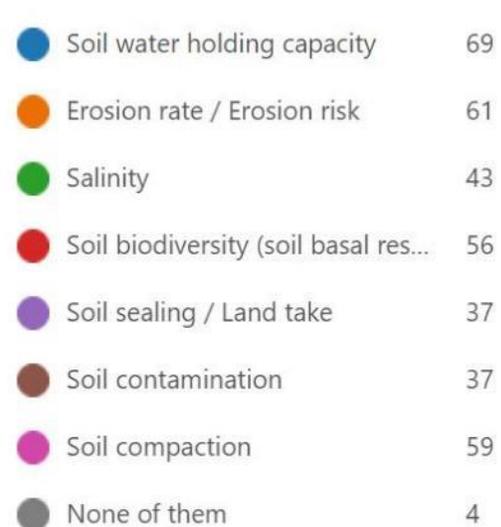


Same prioritisation

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?

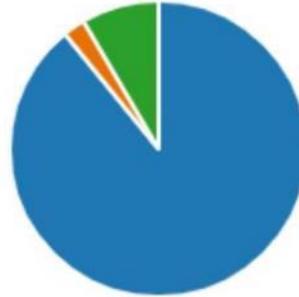
● Yes	19
● No	32
● No, but I would like to learn m...	32



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



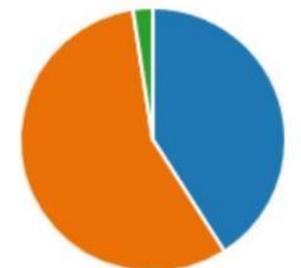
9. Are you missing soil-related information at the Copernicus Land Monitoring Service?

Yes	54
No	2
Maybe	27



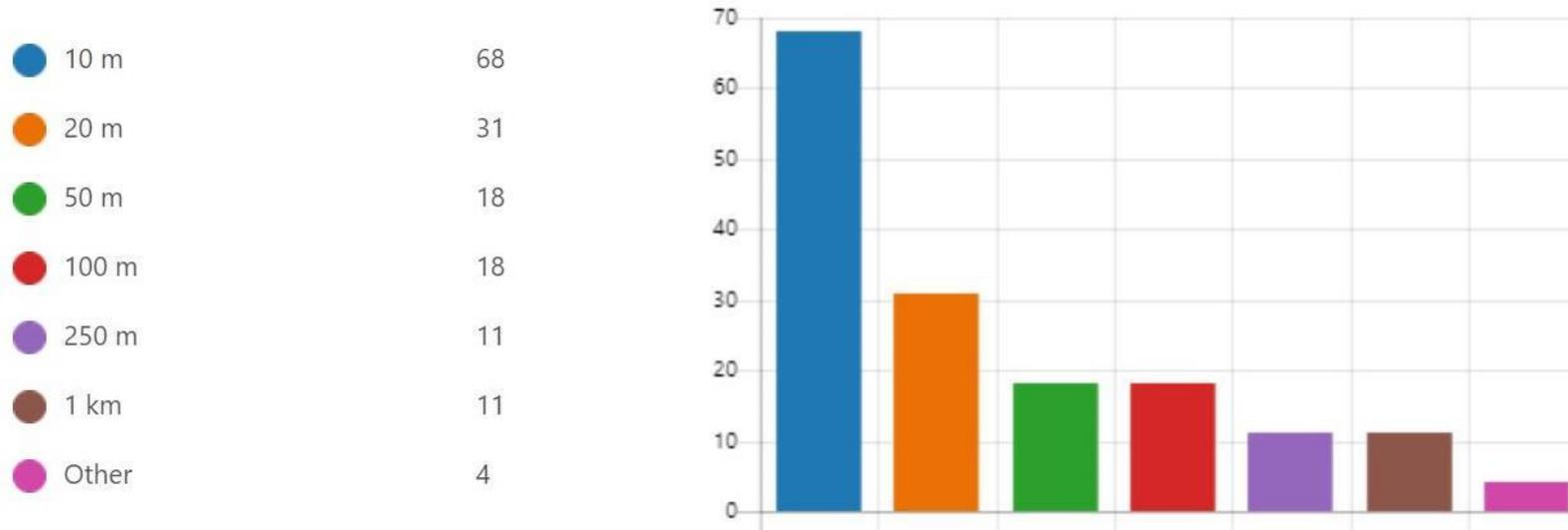
10. How would you rate the use(fulness) of future soil products under the Copernicus land monitoring service?

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



User Survey – Resolution

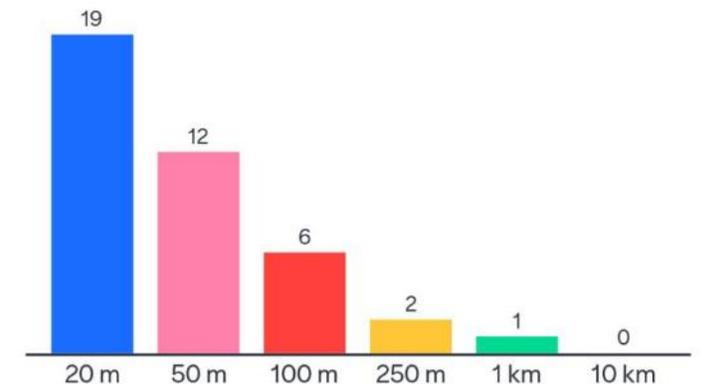
What is your preferred spatial resolution you are working on (in pixel sizes)?



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?

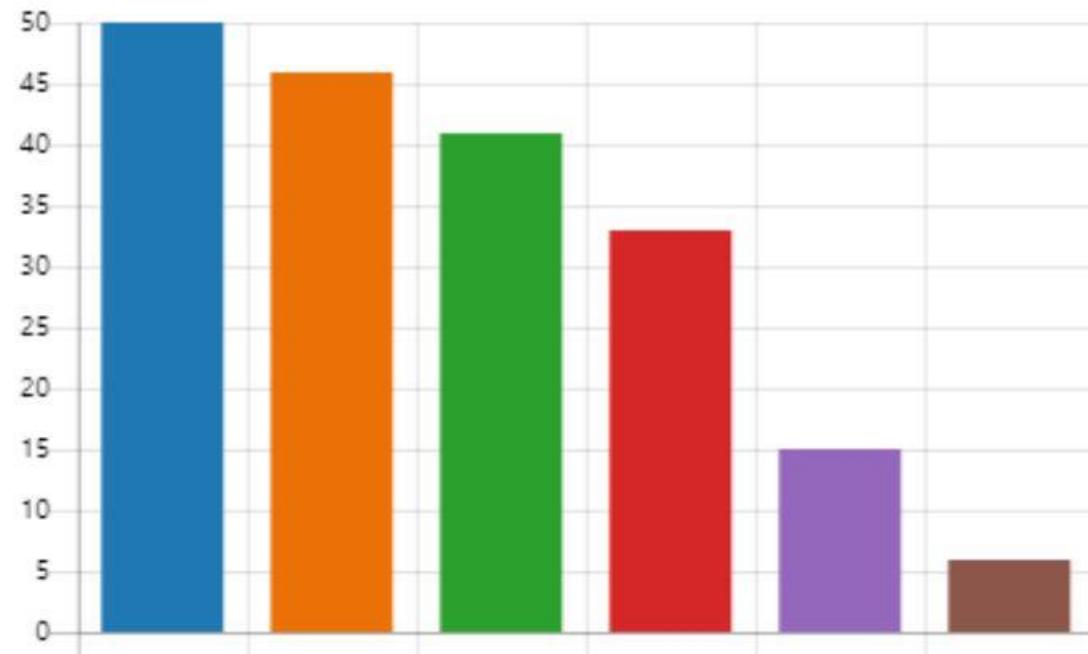
- Spatial pattern should make sense, no absolute accuracy necessary 34
- Correct quantitative values necessary 49



User Survey – Resolution

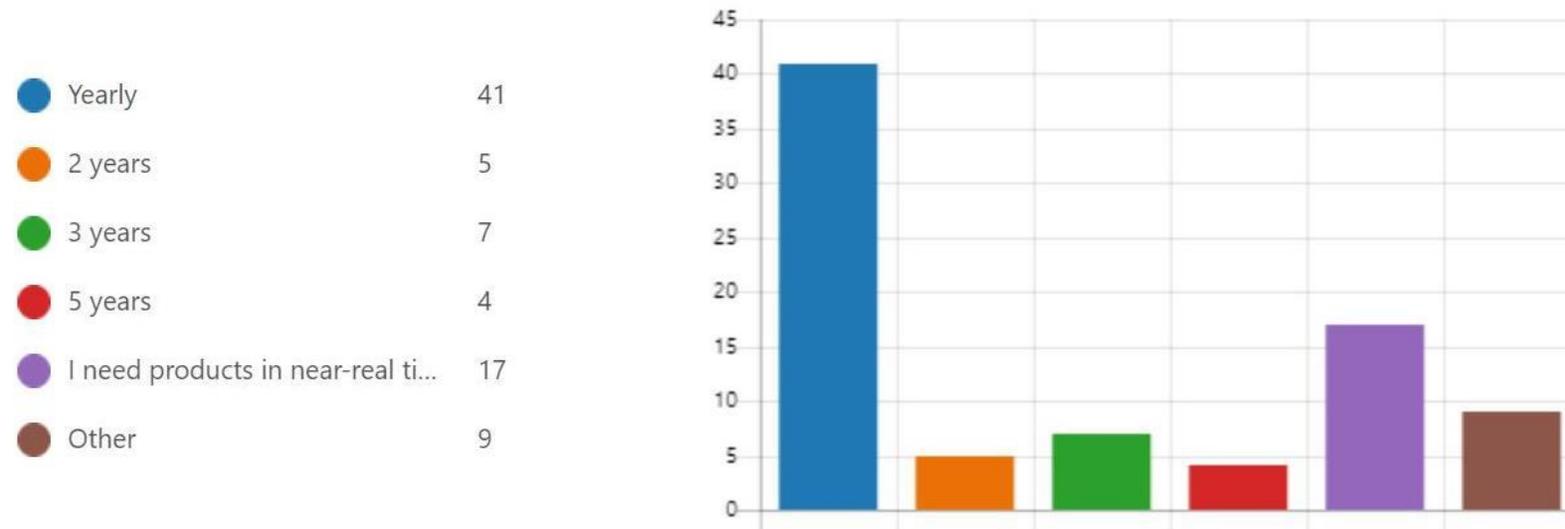
17. Which scale is your organization working on?

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

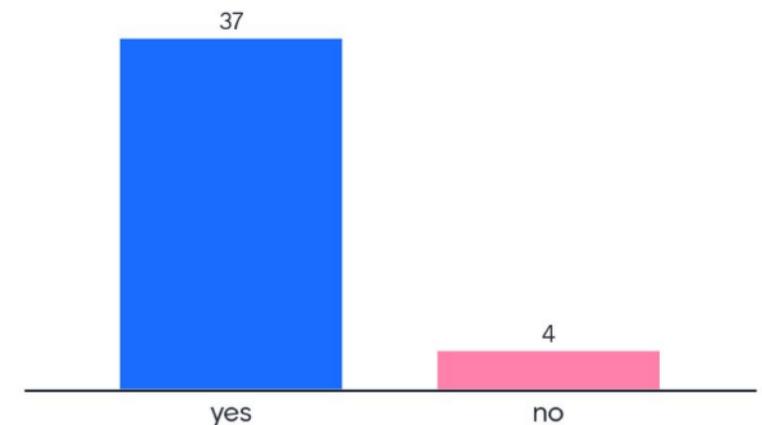


User Survey – Update frequency

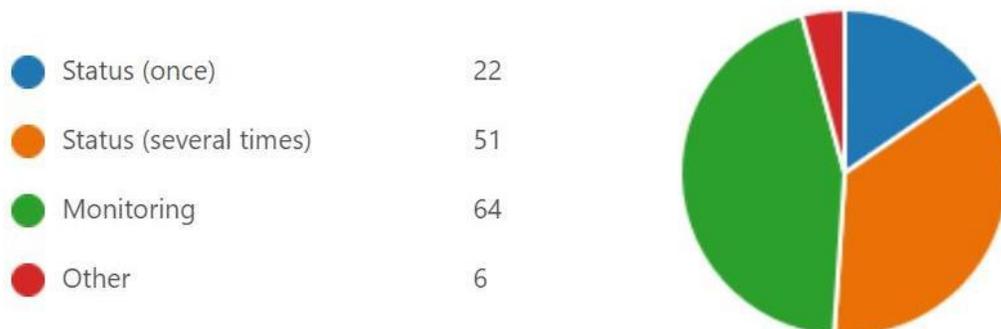
How regularly would you like to get updates on the soil service products?



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?

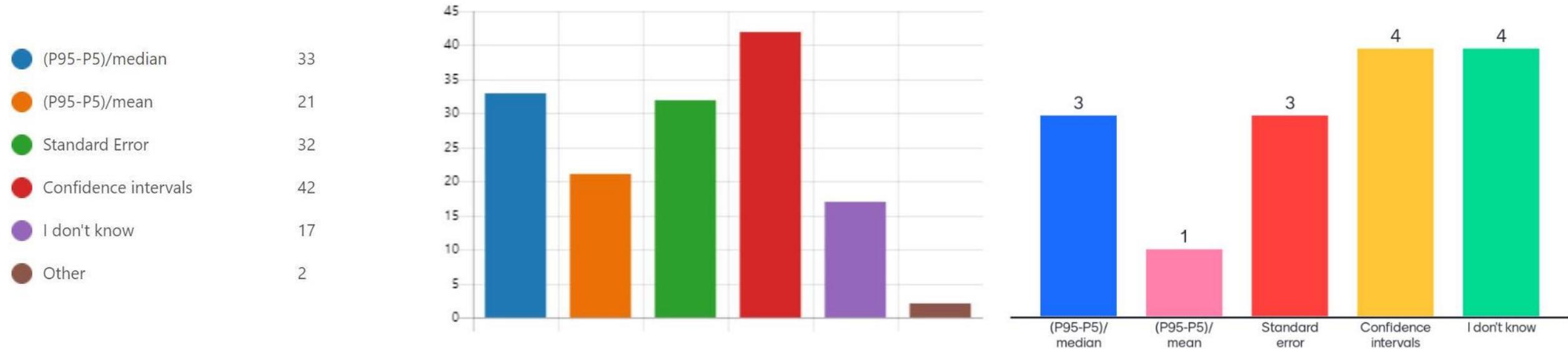


14. For which purpose do you need the soil information?



User Survey – Uncertainty measure

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

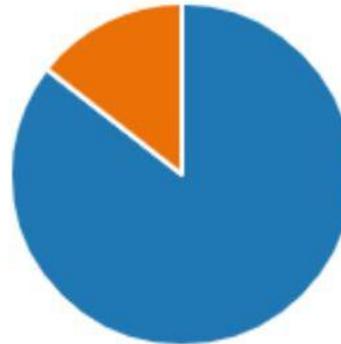


Same top three

User Survey – Access and data format

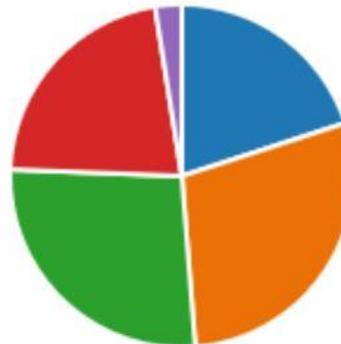
20. What would be your preferred data format?

● Cloud-optimised GEOTIFF	77
● Other	13

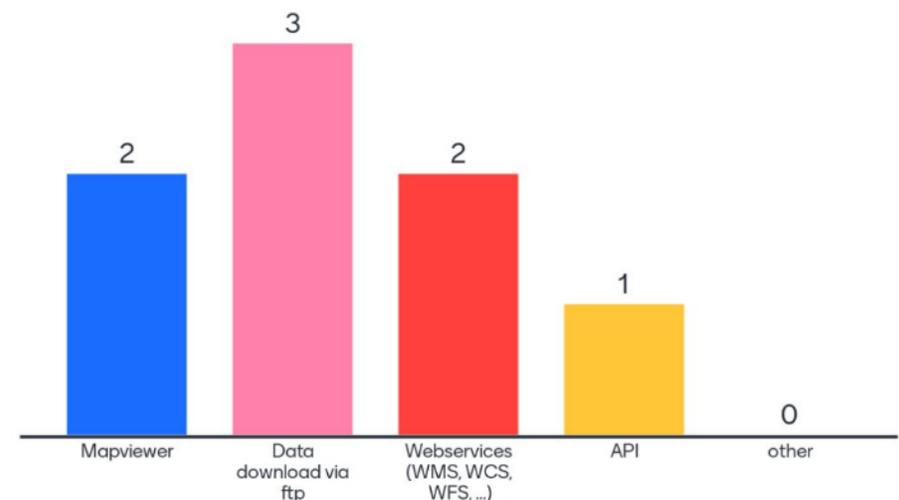


21. What would be your preferred access?

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

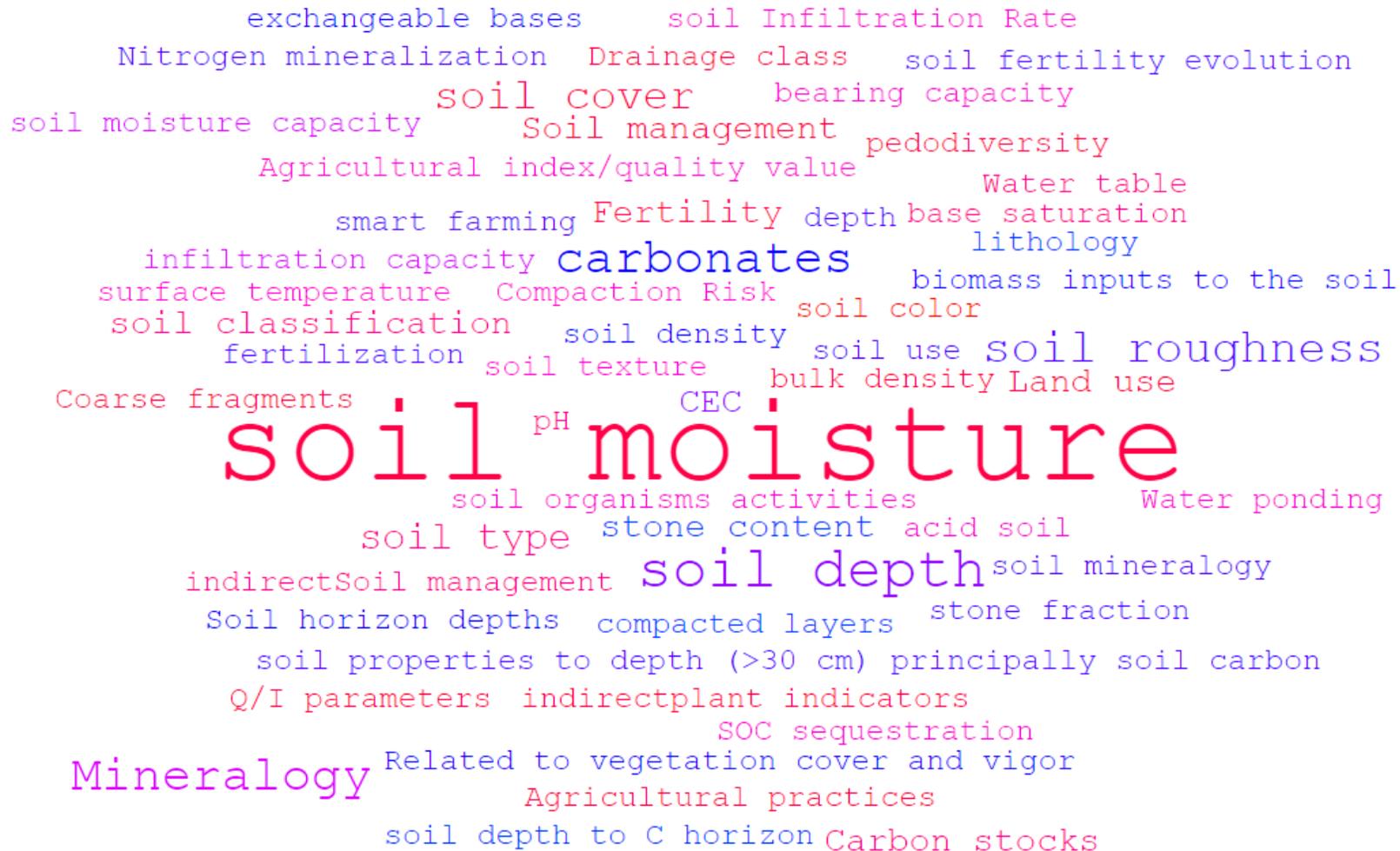


What would be your preferred access?



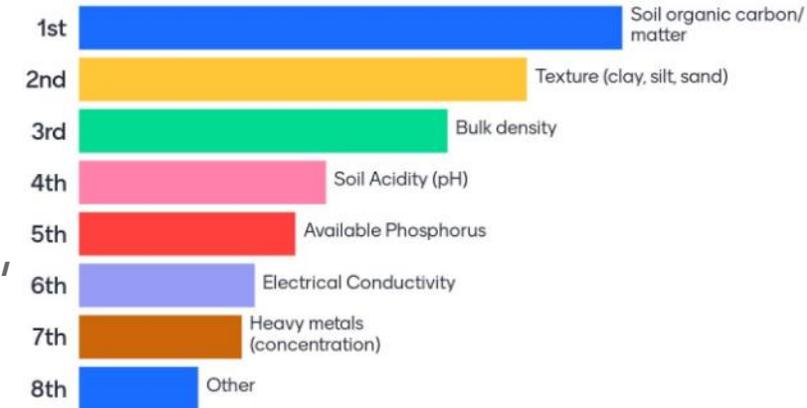
User Survey - Results

Which soil-related spatial information is not listed before?



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.

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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



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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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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