CUP4SOIL:
Wie können zukünftige EO-Bodenprodukte im Rahmen des Copernicus Land Monitoring Service aussehen?

Uta Heiden[1], Pablo d'Angelo[1], Paul Karlshöfer[1], Laura Poggio[2], Fenny van Egmond[2], Thaïsa van der Woude[2], Markus Möller[3]
[1] DLR
[2] ISRIC
[3] JKI

Knowledge for Tomorrow

CUP4SOIL general objective

Objectives

- Prepare a potential Copernicus downstream service to support national and European acteurs for reporting on soil health/quality.

- **Generate European-wide <u>example</u> 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. …
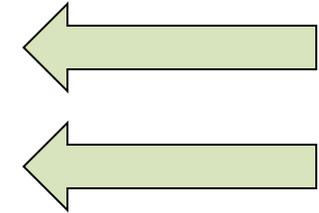
User requirement survey - Development

- A user survey was launched to understand more about the required specifications of the spatial soil products

- 23 questions

- Sent out to people across Europe on soils and EO

- Results will be made publically available via the CUP4SOIL webpage

- Results approved by a interactive questionnaire during the User requirement meeting in Dec 2023
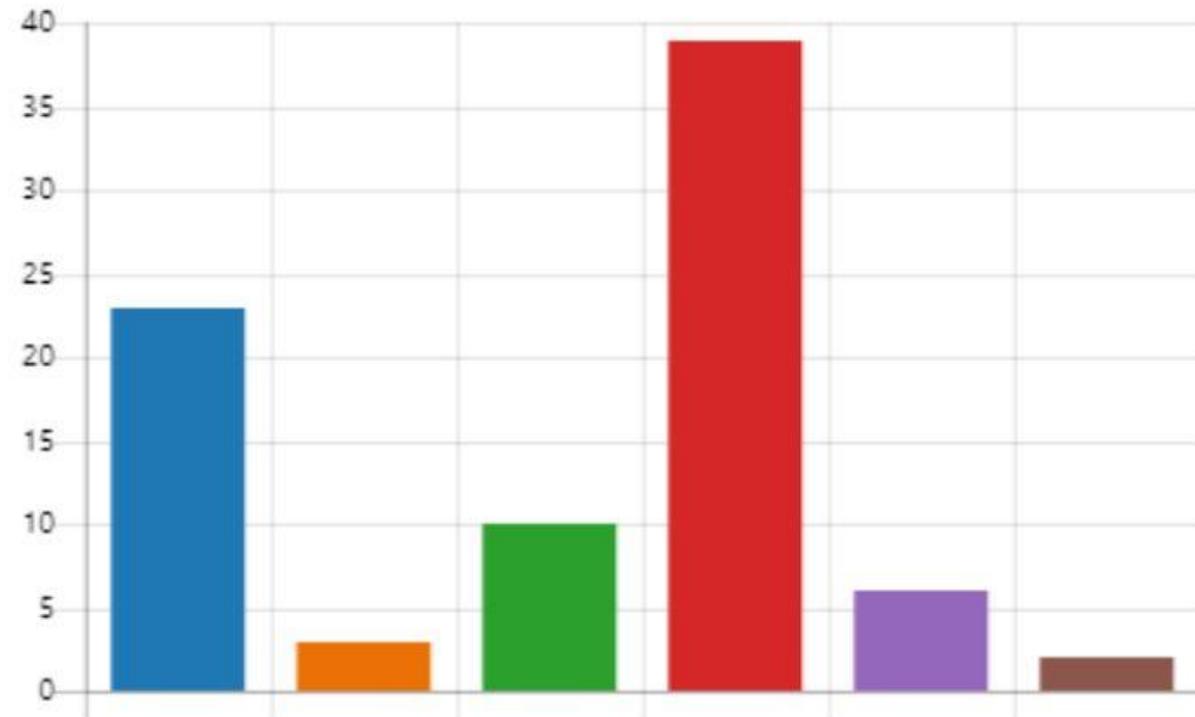
CUP4SOIL Webpage

User requirement survey - Summary

2. What best describes your organization?

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

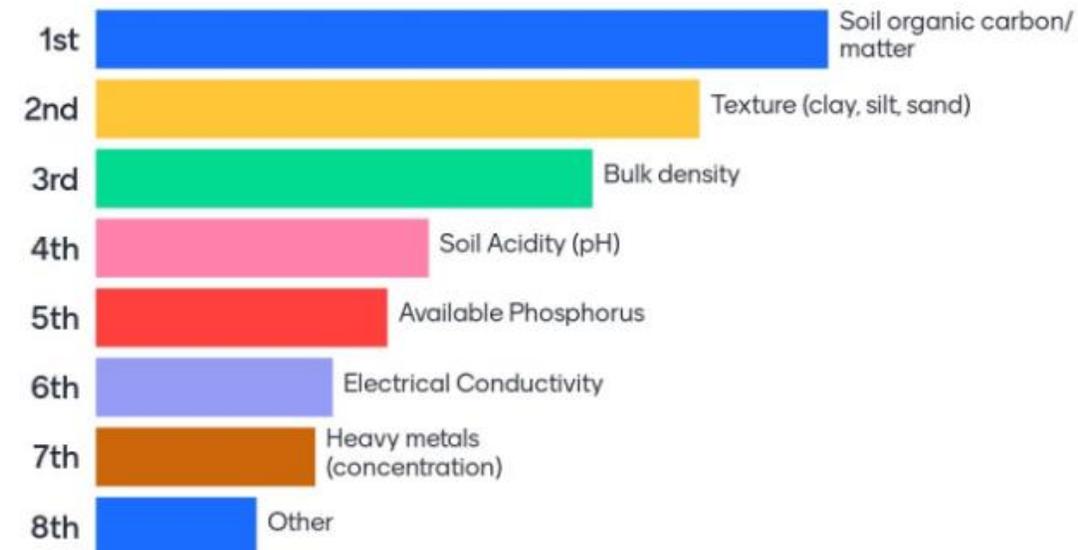# User requirement survey - Summary

- 54 / 83 user are **missing** soil related information at the Copernicus service (24 maybe)

- Most wanted **soil products** are:

  o SOC, texture and bulk density, soil water holding capacity, erosion, soil compaction, soil biodiversity

- Majority needs information for **monitoring yearly**

- Spatial resolution winner is **10 m pixel size**

- Spatial scale: Clear trend from **one or several fields** (50 / 83) to the European scale (15 / 83)

- Very important is to measure the quality/uncertainty: **Confidence interval** (42 / 83)

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

🔵 Status (once)	22	
🟠 Status (several times)	51	
🟢 Monitoring	64	
🔴 Other	6	

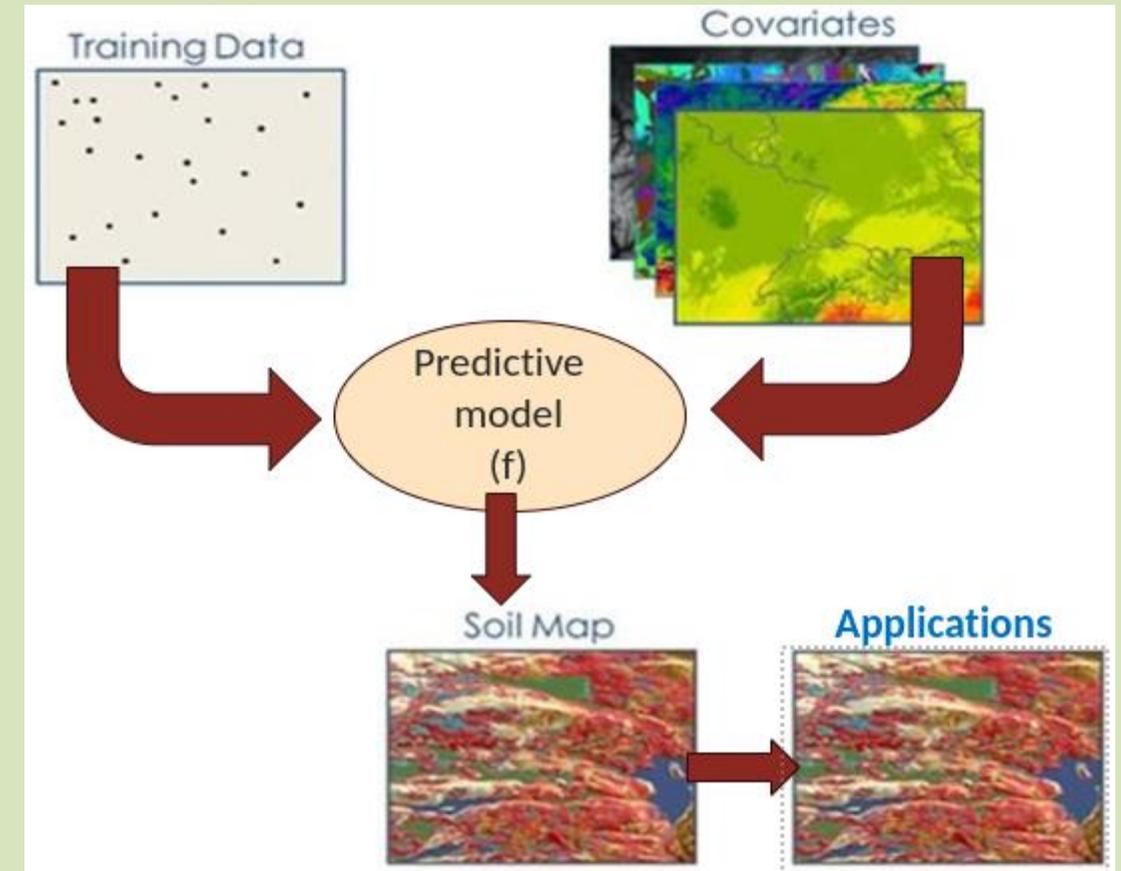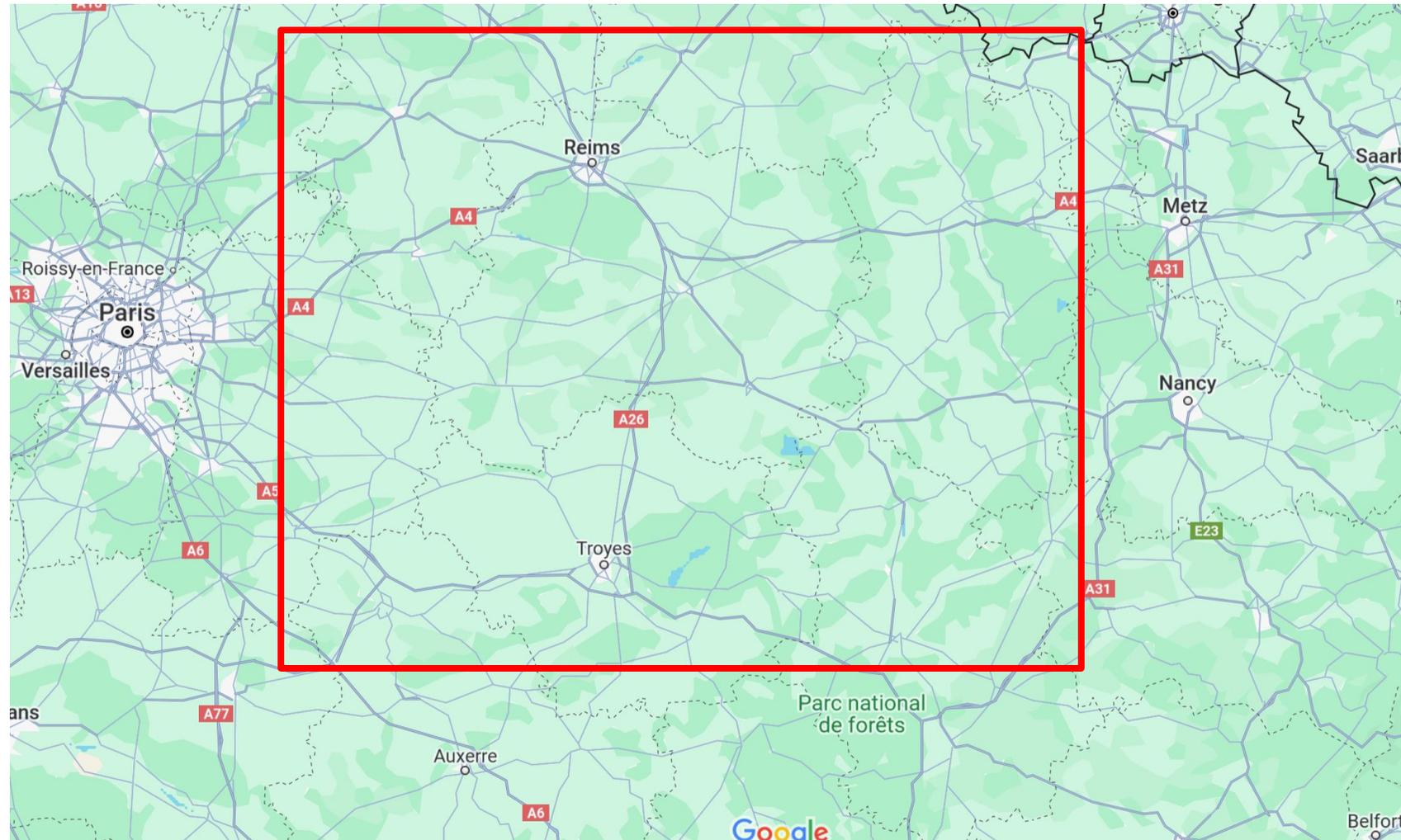Which soil-related spatial information would be helpful for your work (derived/complex properties)?

1st	Soil organic carbon/matter
2nd	Texture (clay, silt, sand)
3rd	Bulk density
4th	Soil Acidity (pH)
5th	Available Phosphorus
6th	Electrical Conductivity
7th	Heavy metals (concentration)
8th	Other

General overview

Soil Composite Mapping Processor (SCMaP)

EO Input data

Sentinel-2 Reflectances + Cloud Masks

European Threshold Database

ESA WorldCover

Temporal Compositing

Averaging

Index calc. + thresholding

Bare surface detection

Cloud and haze filter

Averaging + Statistics

MEAN + STD Bare surface reflectance composite

Mean + STD reflectance composite

Bare surface pixel count

Valid pixel count

Bare surface frequency

Bare surface mask

SCMaP Output

Digital Soil Mapping of ISRIC

Training Data

Covariates

Predictive model (f)

Soil Map

Applications

France

Source: Google maps (https://www.google.de/maps)

Example France
SCMaP products

Mean Surface Reflectance
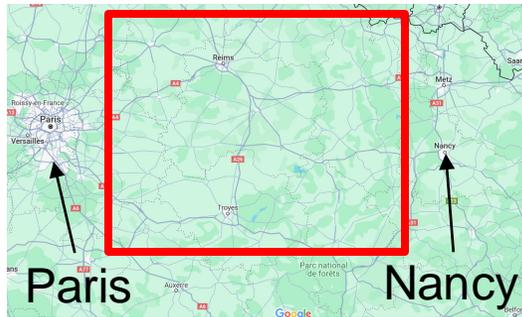
- Sentinel-2
- L2A reflectance (MAJA processed)
- 2018 – 2022

Paris   Nancy

Source: Google maps (https://www.google.de/maps)

Example France
SCMaP products

Bare Soil/Surface Reflectance –

- Sentinel-2
- L2A reflectance (MAJA processed)
- 2018 – 2022
- PV+IR2
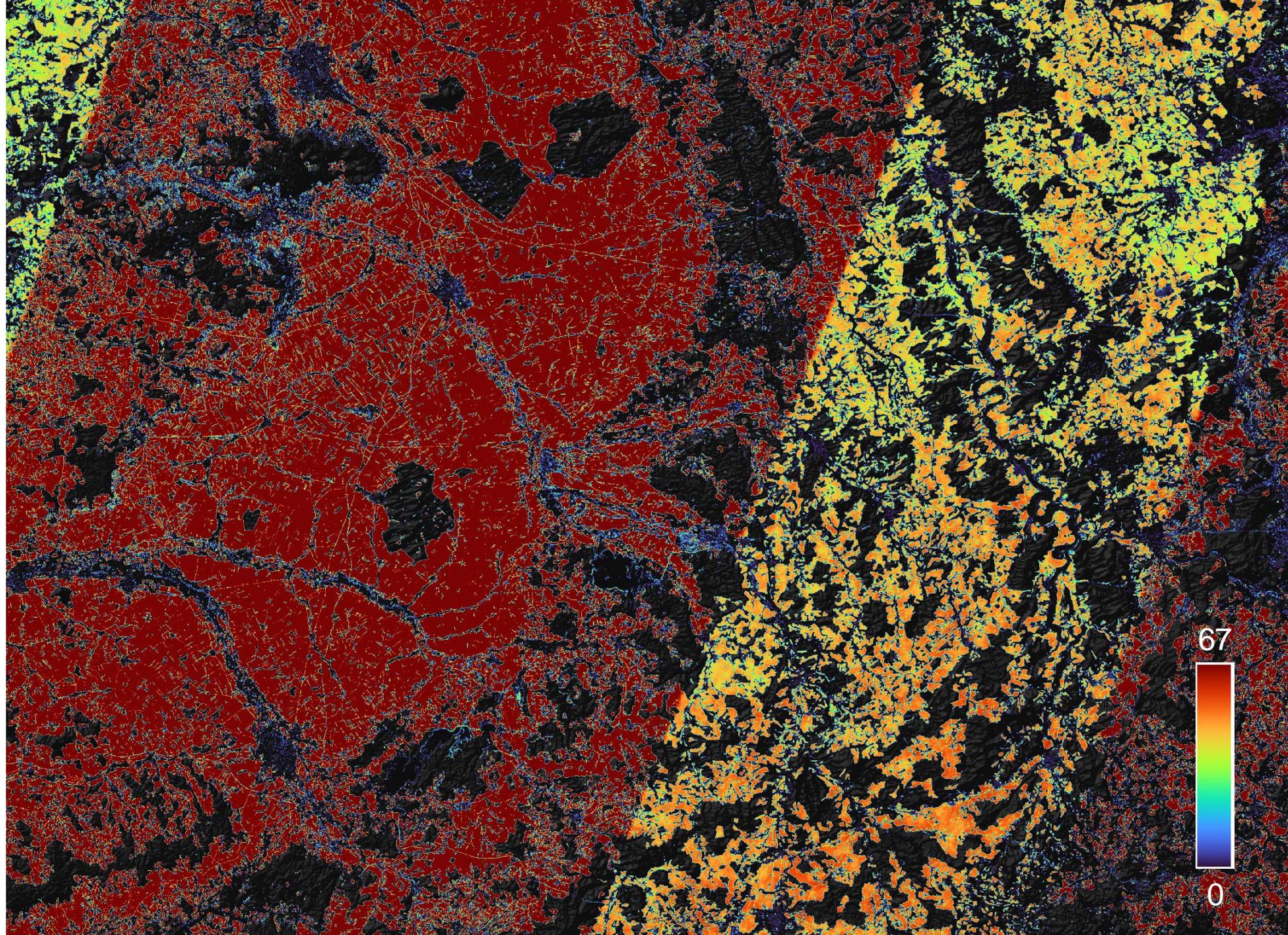- Regionalised thresholds

Paris   Nancy

Source: Google maps (https://www.google.de/maps)
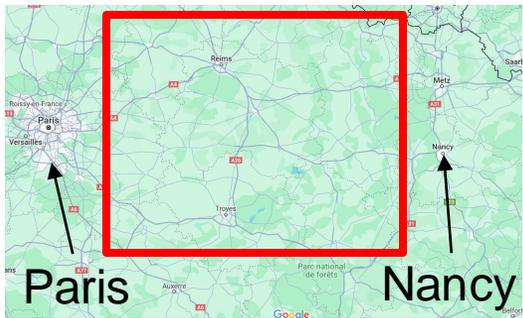
Example France
SCMaP products

Bare Soil/Surface Reflectance –

- Sentinel-2
- L2A reflectance (MAJA processed)
- 2018 – 2022
- PV+IR2
- Regionalised thresholds

Source: Google maps (https://www.google.de/maps)

Paris   Nancy

Source: Google maps (https://www.google.de/maps)
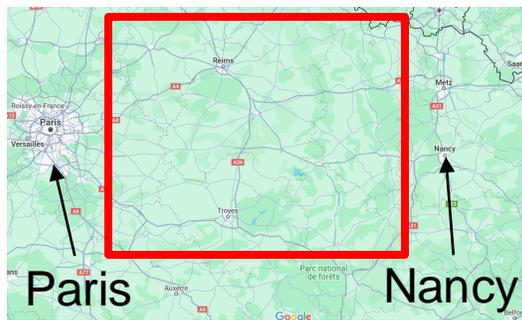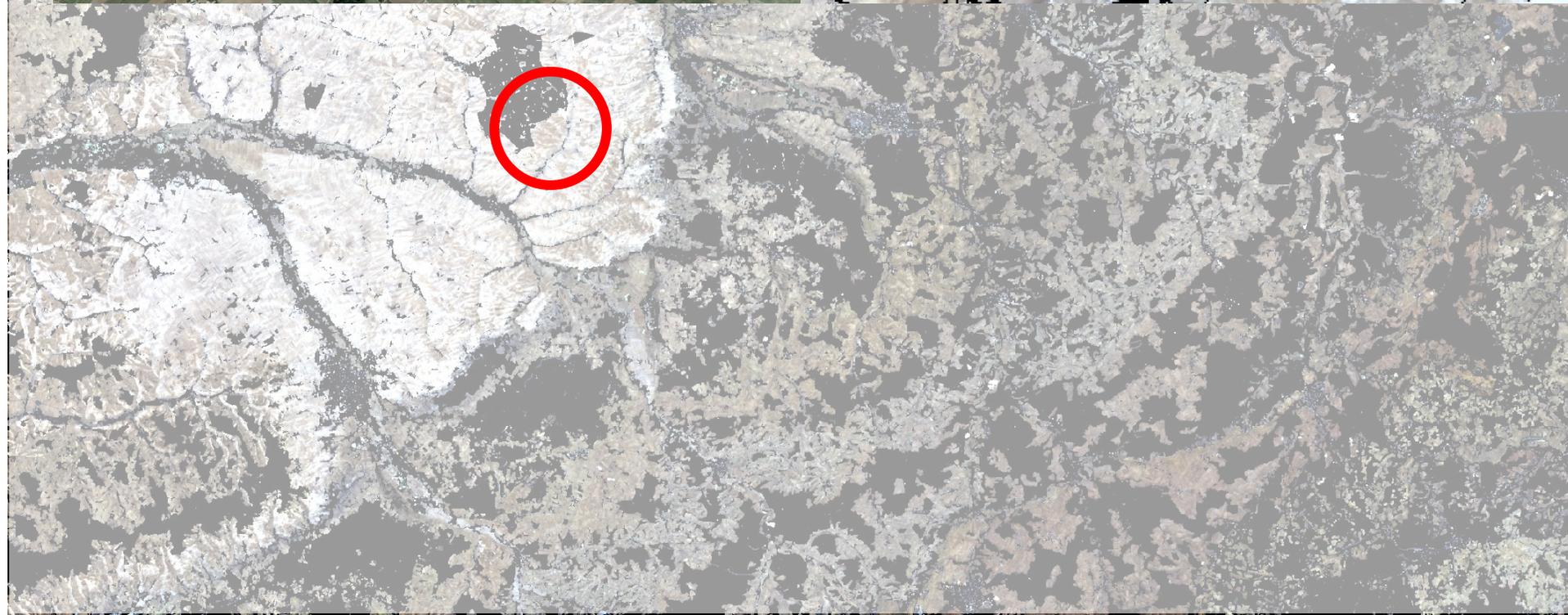
Example France
SCMaP products
Valid Pixel Count

- Sentinel-2
- 2018 – 2022

Paris   Nancy

67

0

Example France
SCMaP products

Bare Soil Frequency [%]

- Sentinel-2
- 2018 – 2022
- PV+IR2
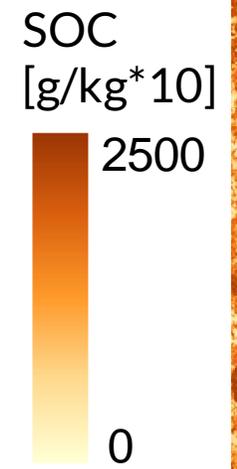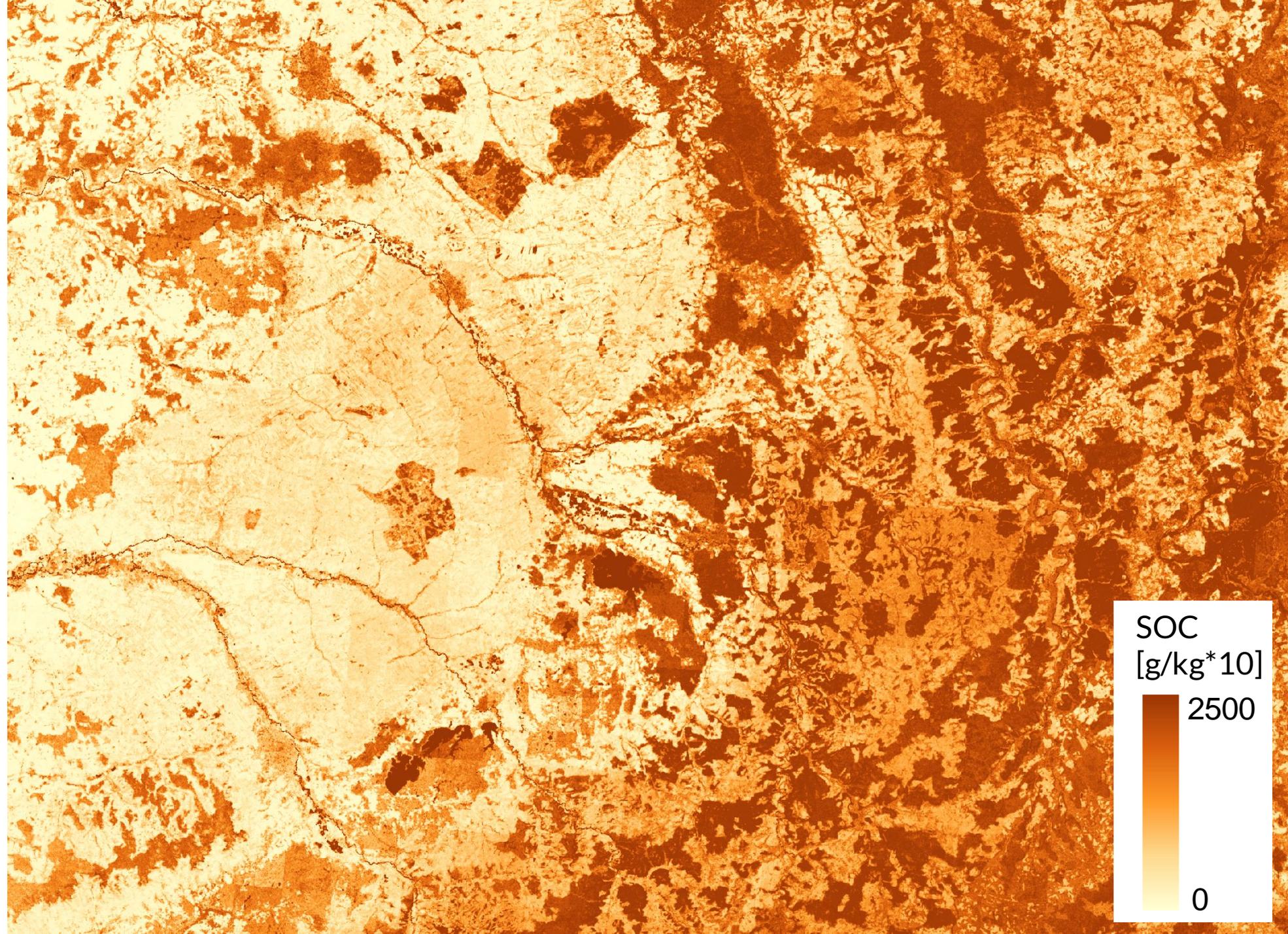- Regionalised thresholds

Paris   Nancy
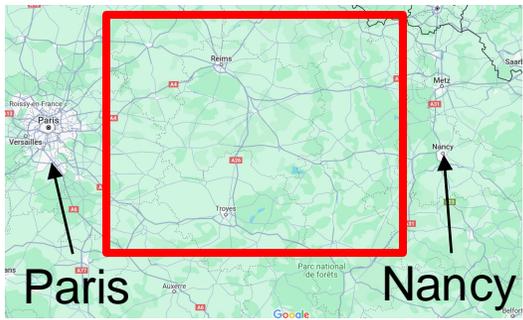
Source: Google maps (https://www.google.de/maps)
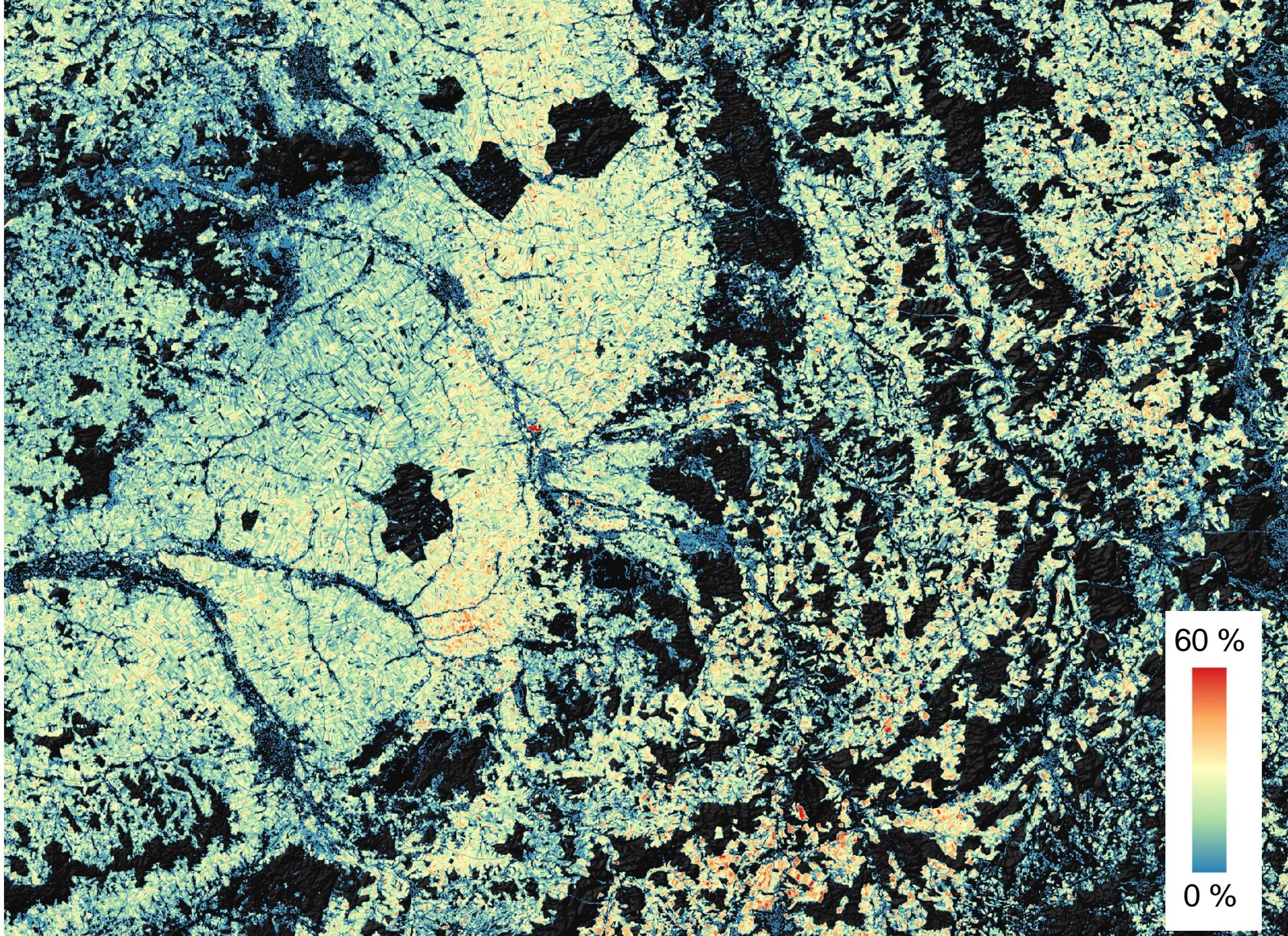
60 %

0 %

Example France
Soil
parameter

Soil Organic Carbon Content

- Topsoil - 0-30cm
- g/kg*10

Paris

Nancy

Source: Google maps (https://www.google.de/maps)

SOC
[g/kg*10]

2500

0
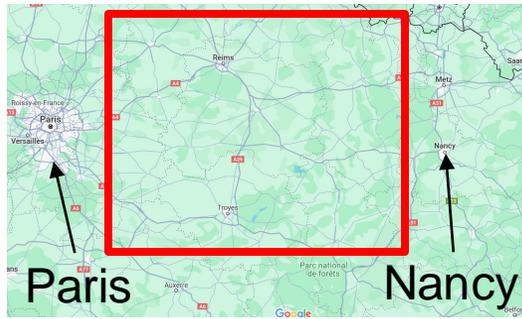
Example France
Soil
parameter

pH in water

- Topsoil - 0-30cm
- pH*10

pH
[pH*10]

78

43

Paris

Nancy

Source: Google maps (https://www.google.de/maps)
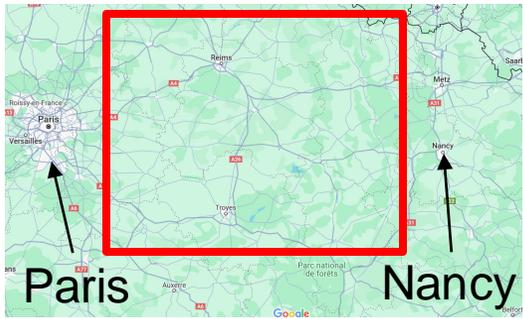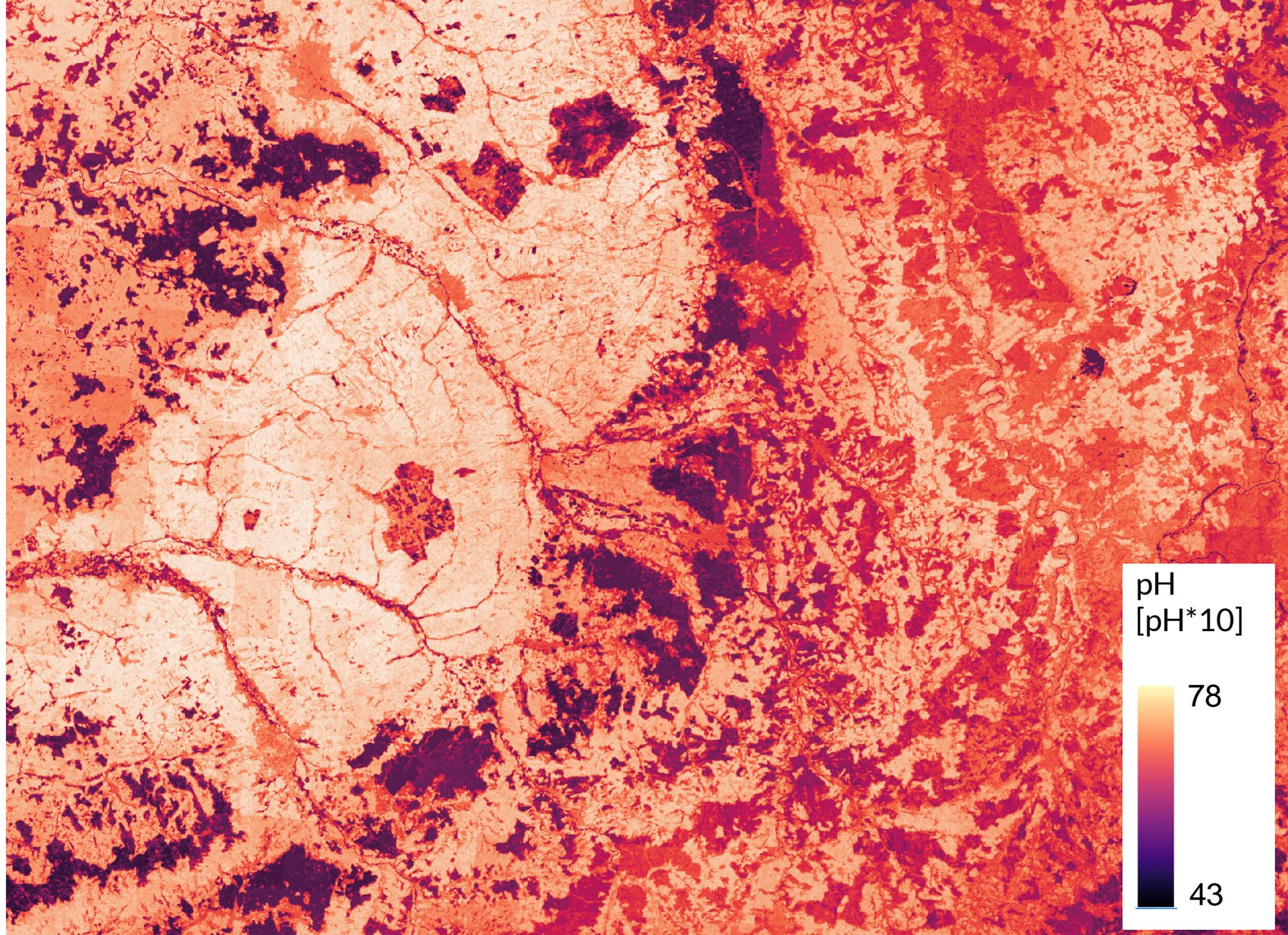
Example France
Soil
parameter
Total Nitrogen

- Topsoil - 0-30cm
- [g/kg*10]
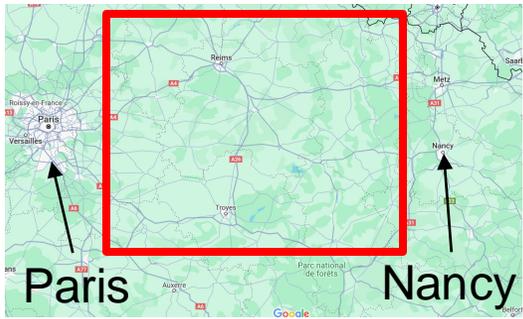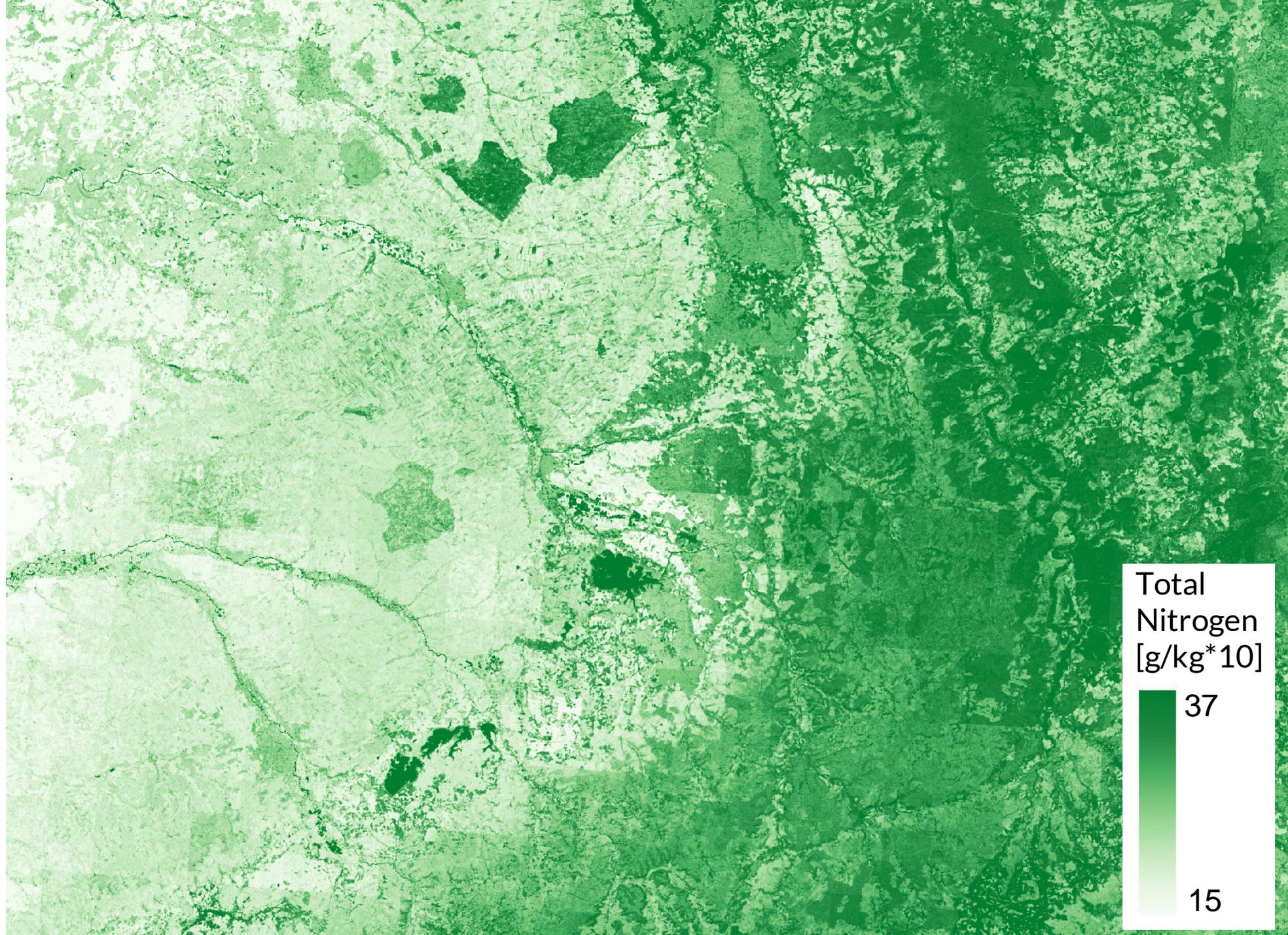
Total
Nitrogen
[g/kg*10]

37

15

Paris   Nancy

Example France
Soil parameter

Bulk density, oven dry

- Topsoil - 0-30cm
- [kg/dm^3]

Bulk Density [kg/dm^3]

140

80

Paris   Nancy
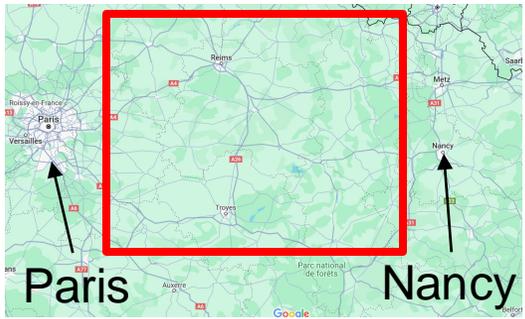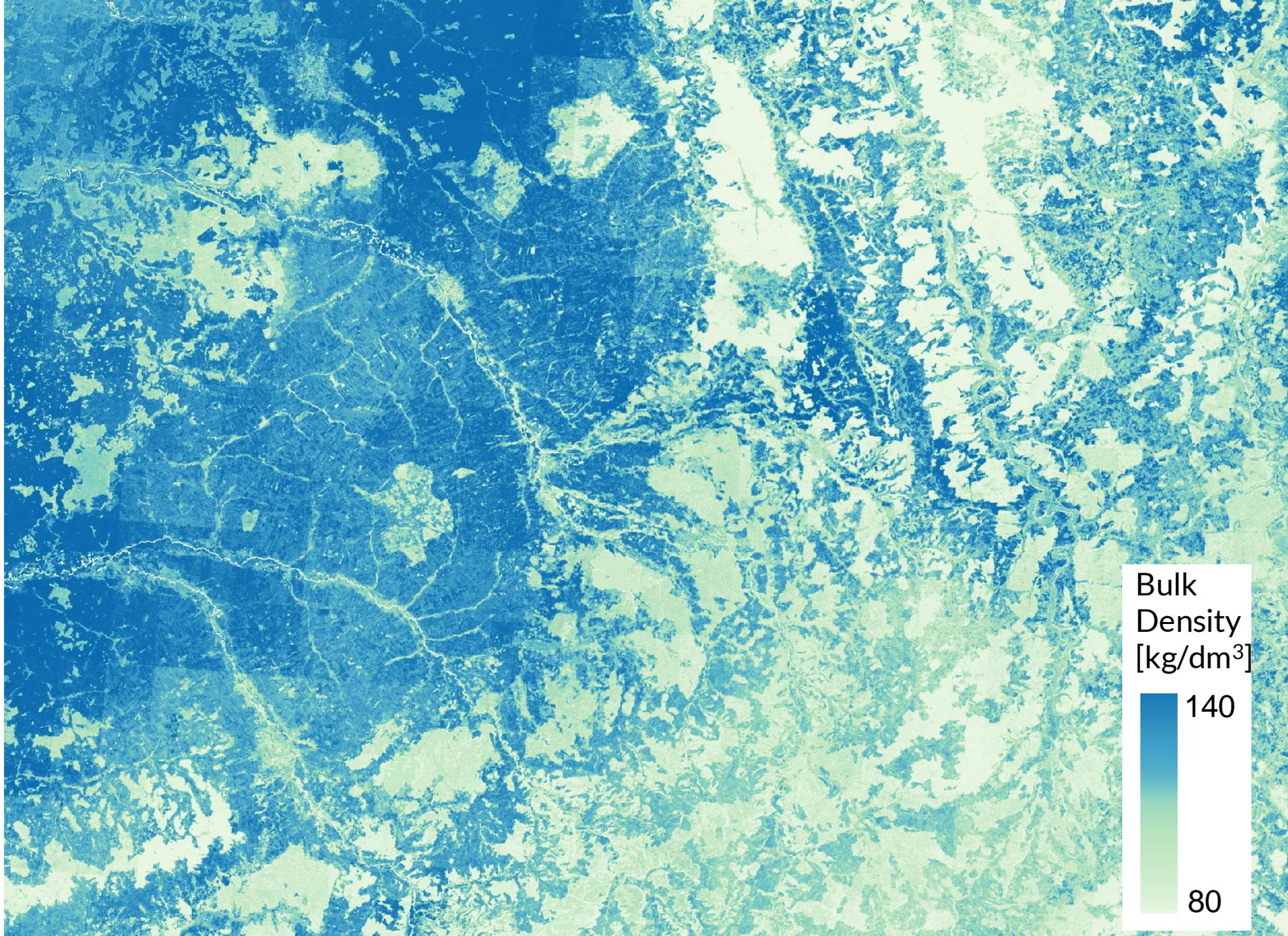
Cross-validation

1

- DEM, land cover, etc. (Copernicus layers)
- Geology/parent material (JRC)
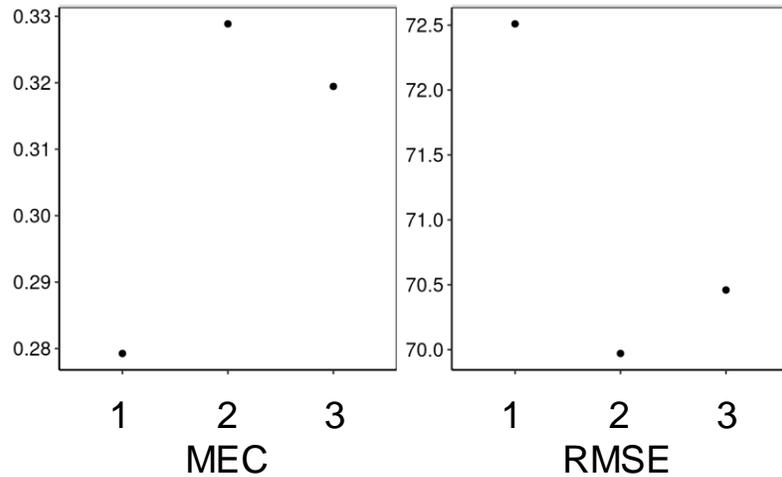- Simple radar products from Sentinel1

2

- DEM, land cover, etc. (Copernicus layers)
- Geology/parent material (JRC)
- Simple radar products from Sentinel1
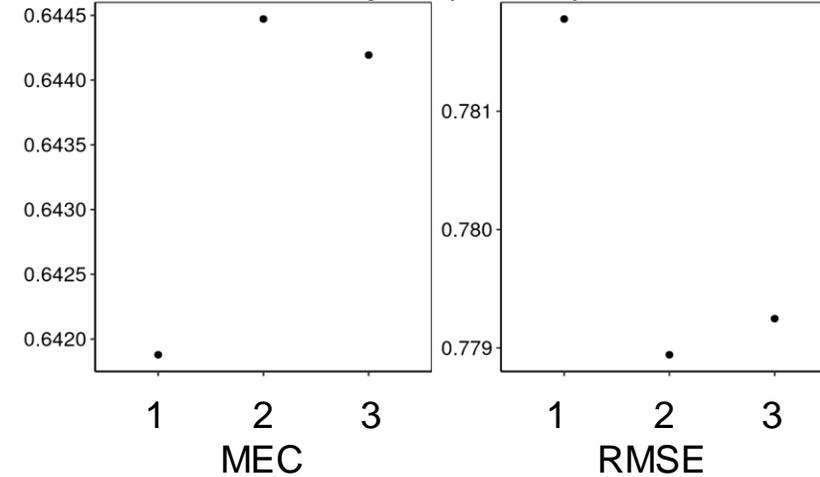- SCMaP: Mean reflectance composite (MEAN)

3

- DEM, land cover, etc. (Copernicus layers)
- Geology/parent material (JRC)
- Simple radar products from Sentinel1
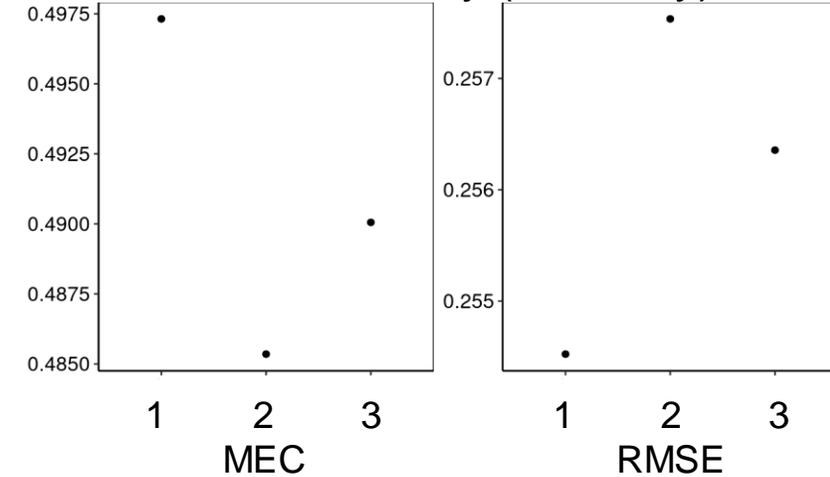- SCMaP: Mosaic of MEAN and soil reflectance composite (SRC)

SOC

pH (water)

Bulk density (oven dry)

MEC   RMSE   MEC   RMSE   MEC   RMSE

*MEC - model efficiency coefficient, equivalent to R^2

Oderbruch

- Agricultural area (Oderbruch) at the border between Poland and Germany

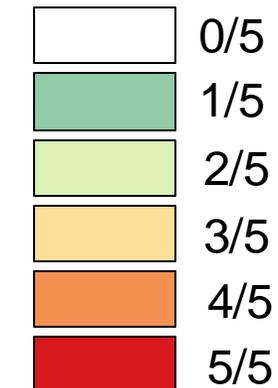Source: Google maps (https://www.google.de/maps)

Application
Oderbruch
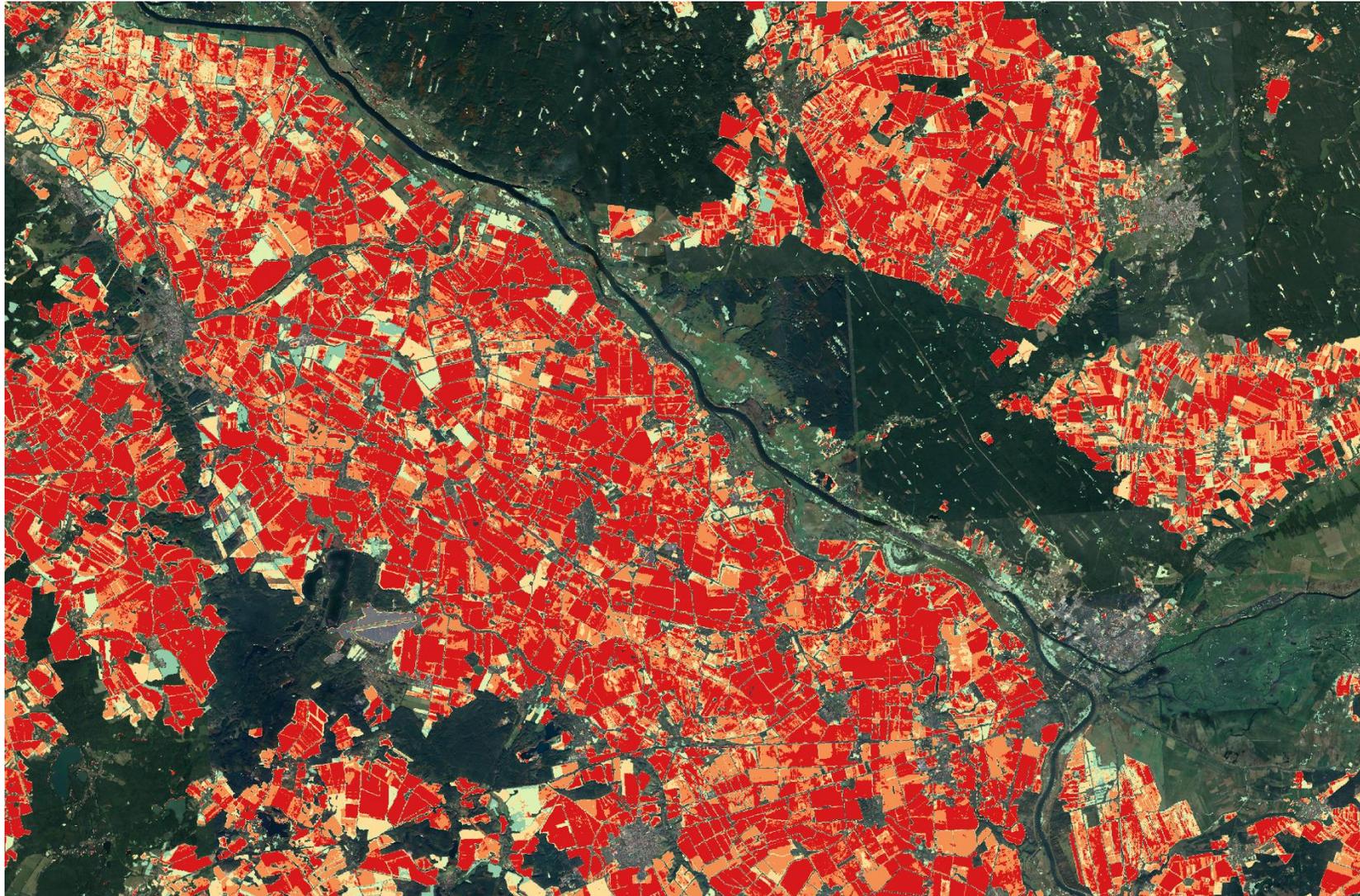
- Agricultural area (Oderbruch) at the border between Poland and Germany

- Yearly bare soil appearance (2018 – 2022) -> request from Project CropGrün

2018 – 2022
Umbruch

	0/5
	1/5
	2/5
	3/5
	4/5
	5/5

Source: Google maps (https://www.google.de/maps) overlayed by data produced by DLR

Summary and future developments

Summary:

- DLR and ISRIC partnered to produce European-wide:

    - SCMaP intermediate products

    - Final soil parameter

- Test about the beste choise of covariates – direct spectral covariates could improve the modelling

- Data will be published and made available free and open

Future developments:

- Preparing the webserver

- Pixel-based uncertainty

- External validation (show-cases)

CUP4SOIL - Thank you very much!

Laura.Poggio@isric.org
fenny.vanegmond@isric.org
uta.heiden@dlr.de

Photo: Uta Heiden