



Earth Observation as a trustworthy technique for monitoring soil parameters

ESA SYMPOSIUM ON EARTH OBSERVATION FOR
SOIL PROTECTION AND RESTORATION

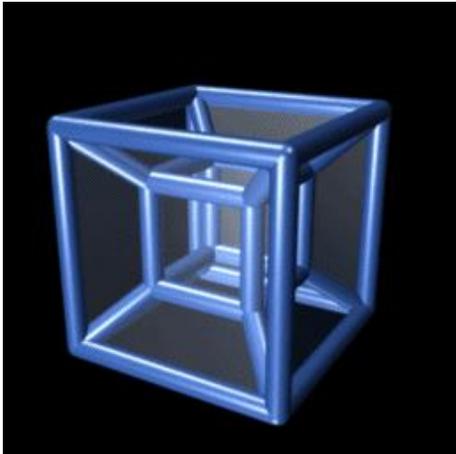
Rainer Baritz/EO 4 Soil/
06 March 2024

Soil

Soil is a 3-dimensional body of mineral and organic matter, organisms, air and **water**, covering the earth's terrestrial surface

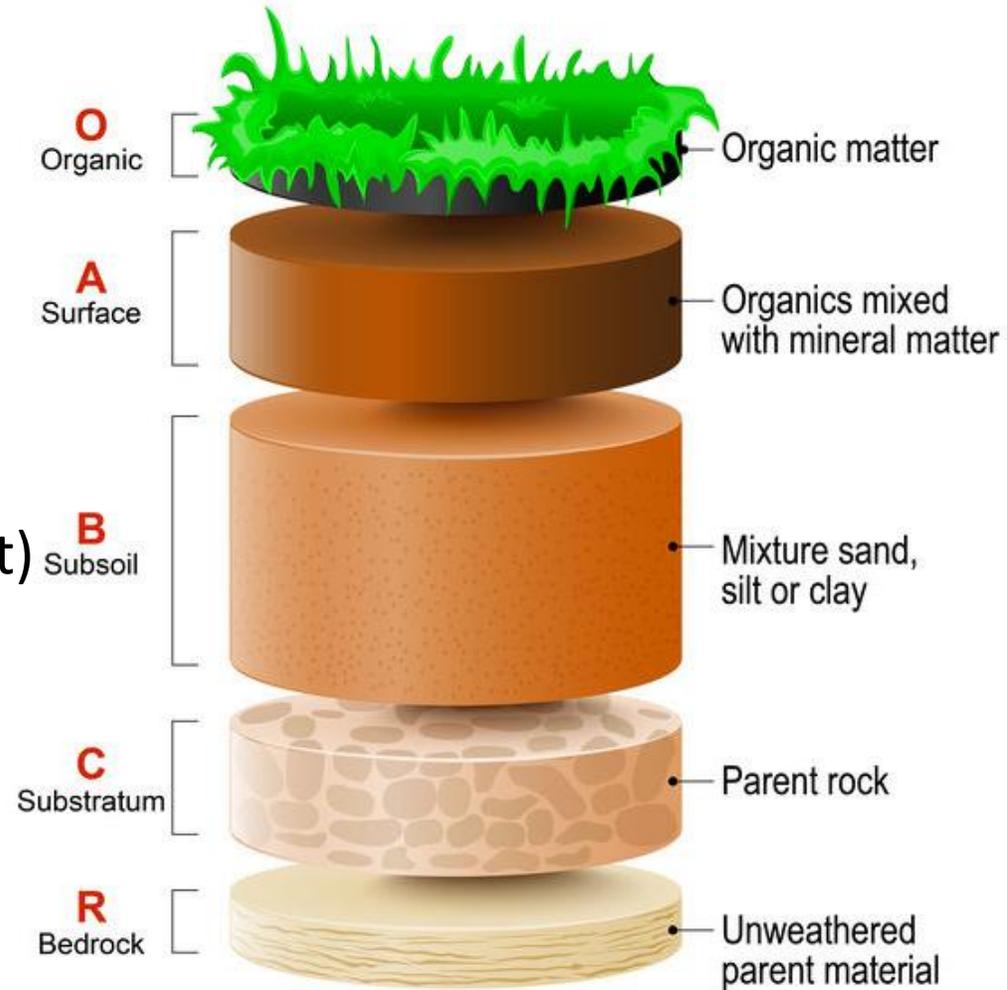
- with lateral/vertical matter transport
- with biological hotspots and reactive inner surfaces

- is often covered with **vegetation**, and organic matter (forest floors, peat)
- **changes** its surface (organic layers, perturbations, erosion, compaction, crusting)
- **changes** (somewhat) and inner structure under management and climate.



4D equiv. Tesseract (Wikipedia)

Soil layers and horizons over parent rock (or groundwater)



Zhabska T. ([link](#))

Healthy soils - enabling resilient ecosystems

Proposal EU Soil Monitoring Law

05 July 2023

➤ **Food security:** biomass growth (incl. crop yields) depends on **sufficient nutrients and water** in the topsoil layer of healthy soils.

Water provision: soils with **sufficient organic matter** can hold up to 10-20 times their weight in water

➤ **Soil biodiversity:** healthy soils provide **sufficient habitat** for a diverse and complex soil food web, able to control potentially harmful organisms

Currently, 60 to 70% of soils in the EU are not in a healthy state

(Veerman et al. 2020)



Aim of monitoring: “Functional” soil indicators

Measured through soil chemical, physical and biological parameters

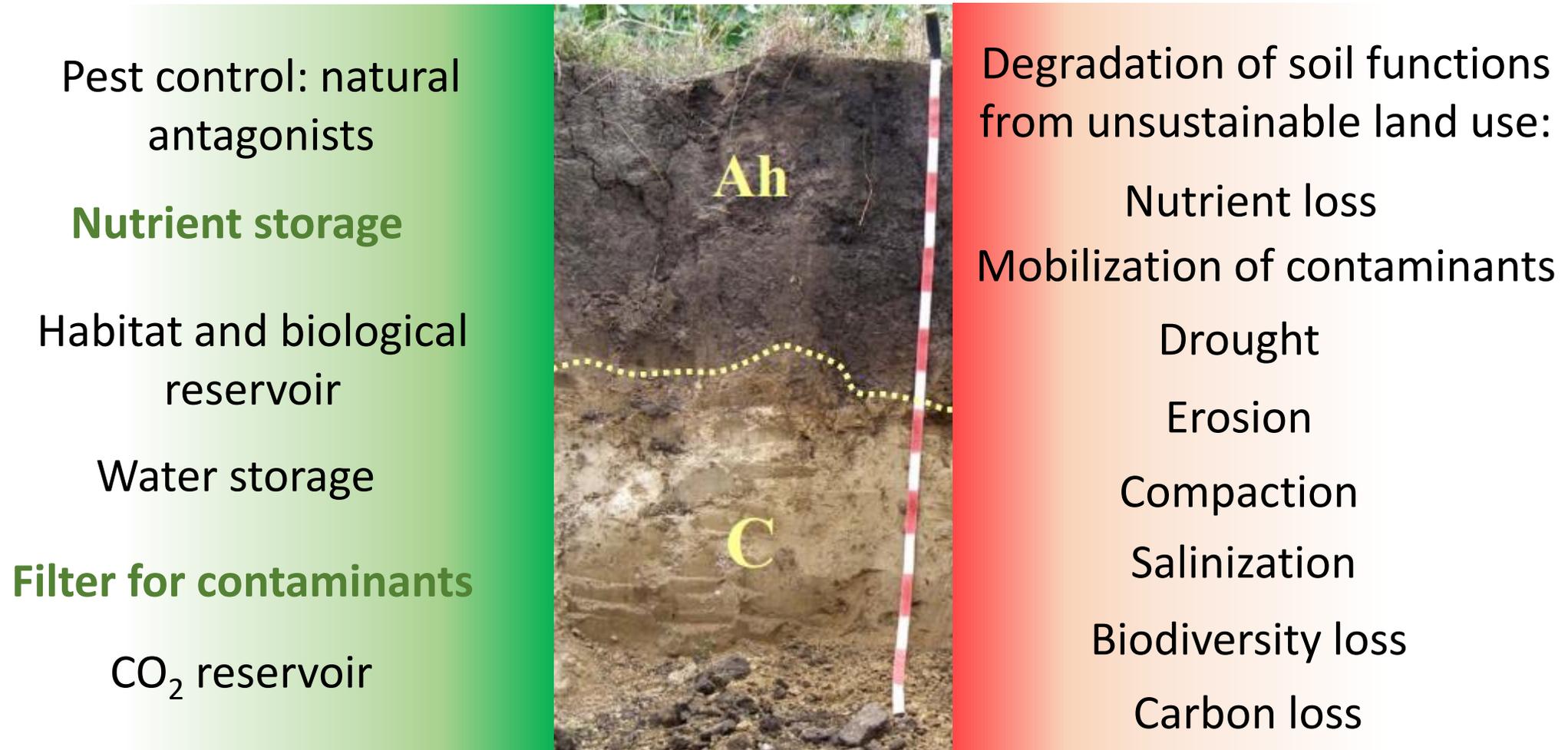
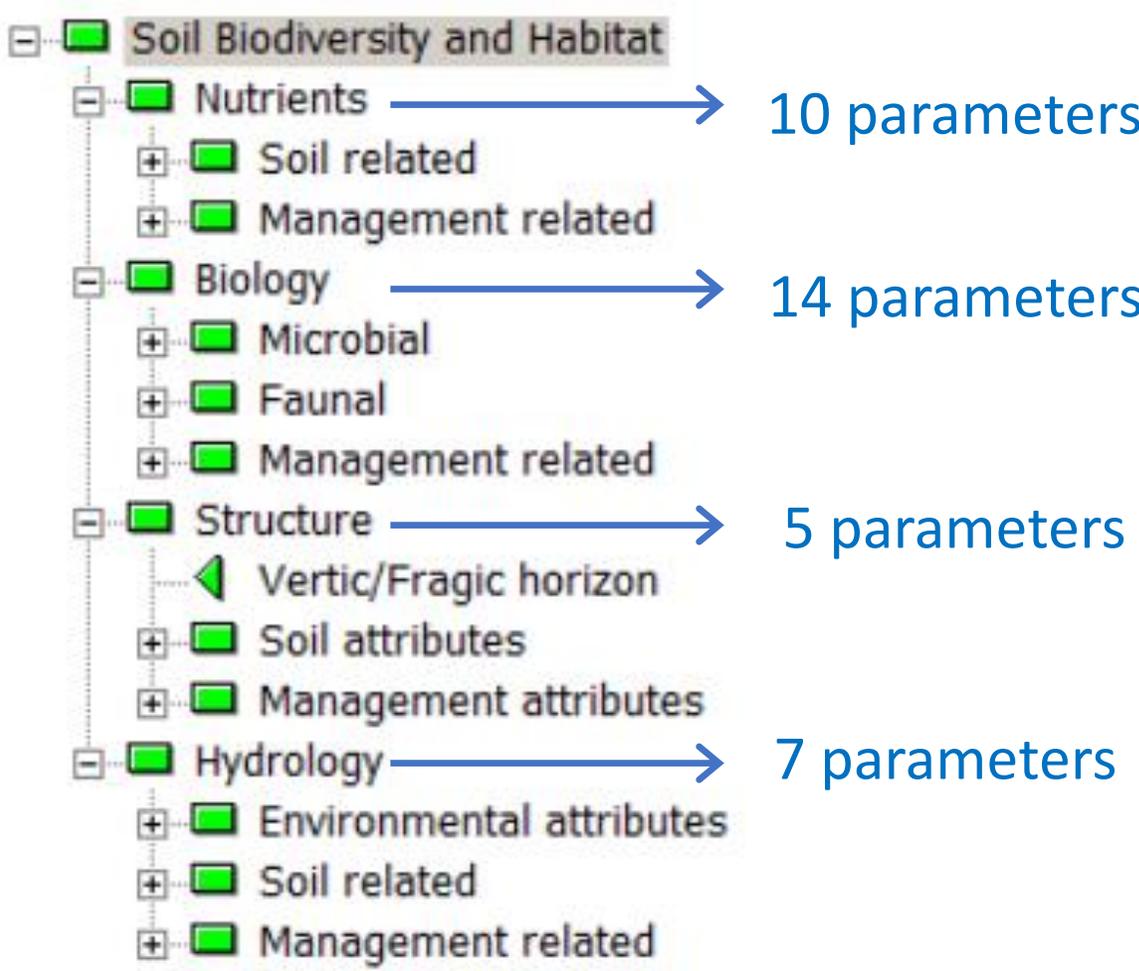


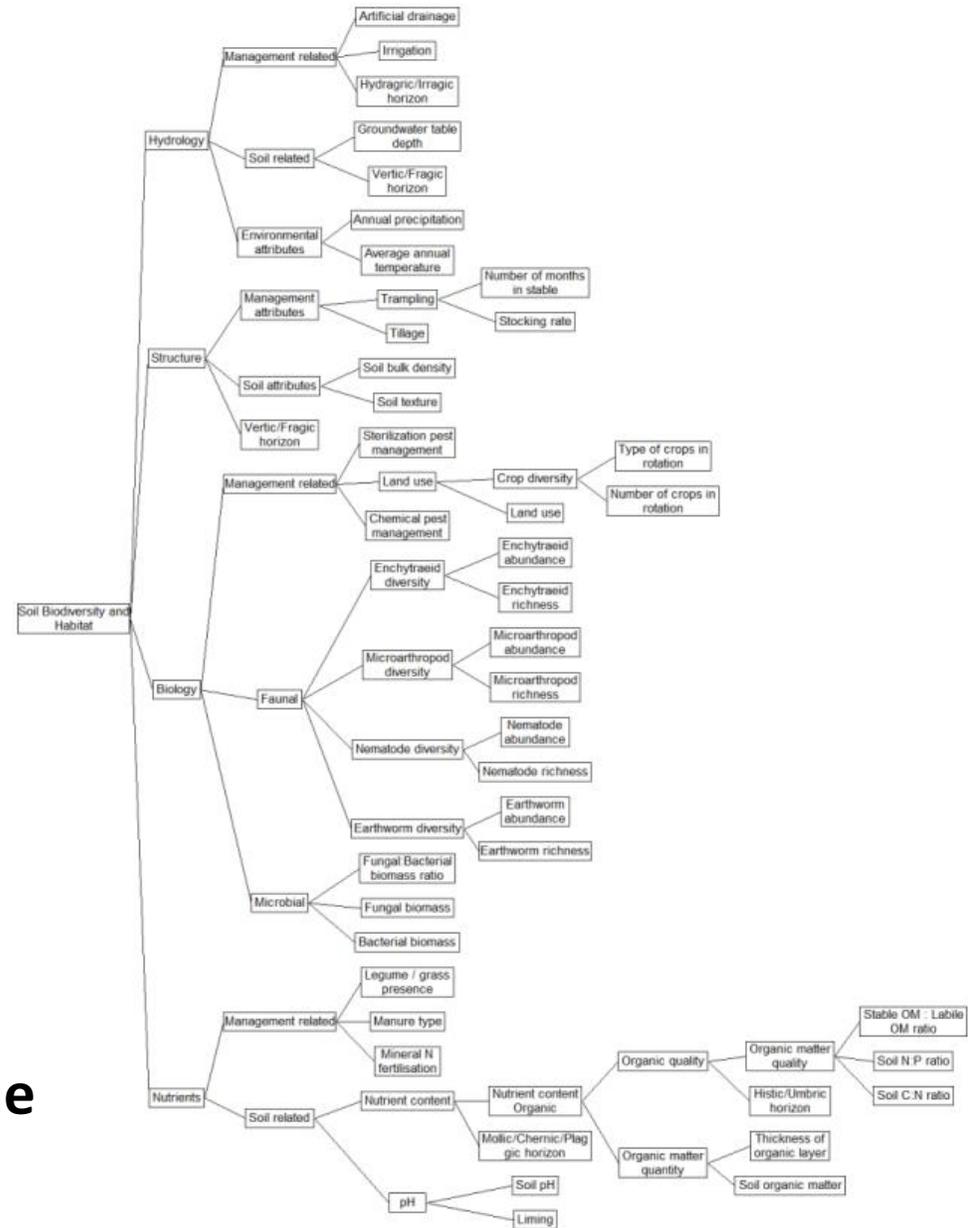
Photo: W. Riek

Soil functions support ecosystem services

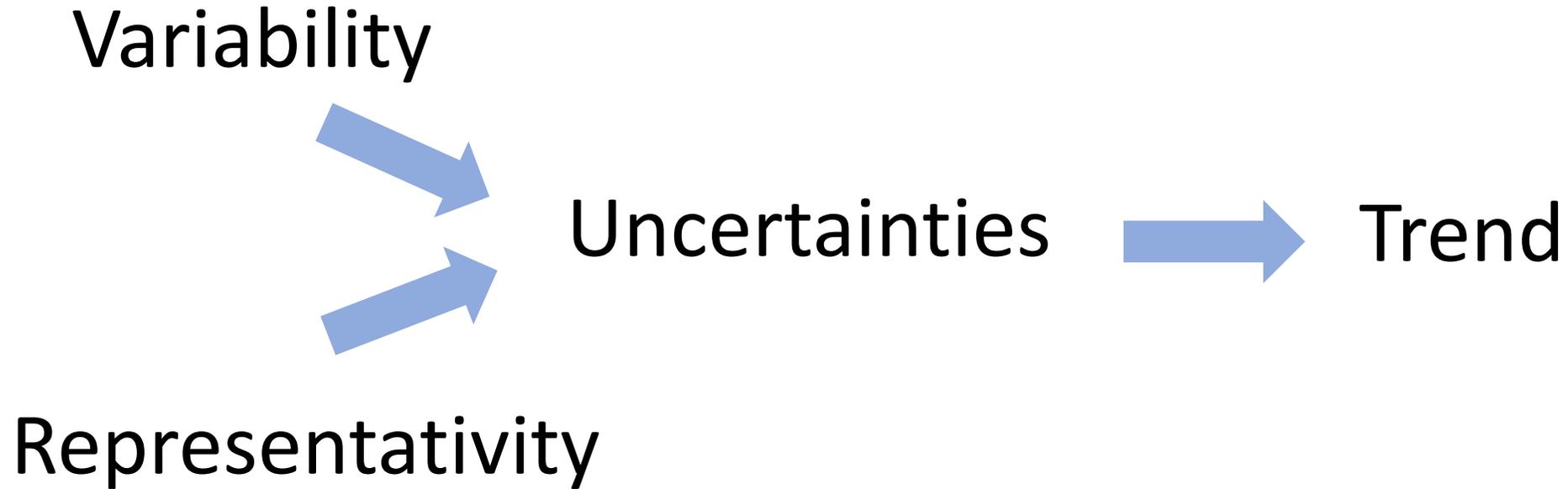
Many “parameters” (descriptors) and soil indicators necessary to assess the soil functions



EU Landmark project (Rutgers et al. 2018): structure of the decision model for soil biodiversity and habitat provision



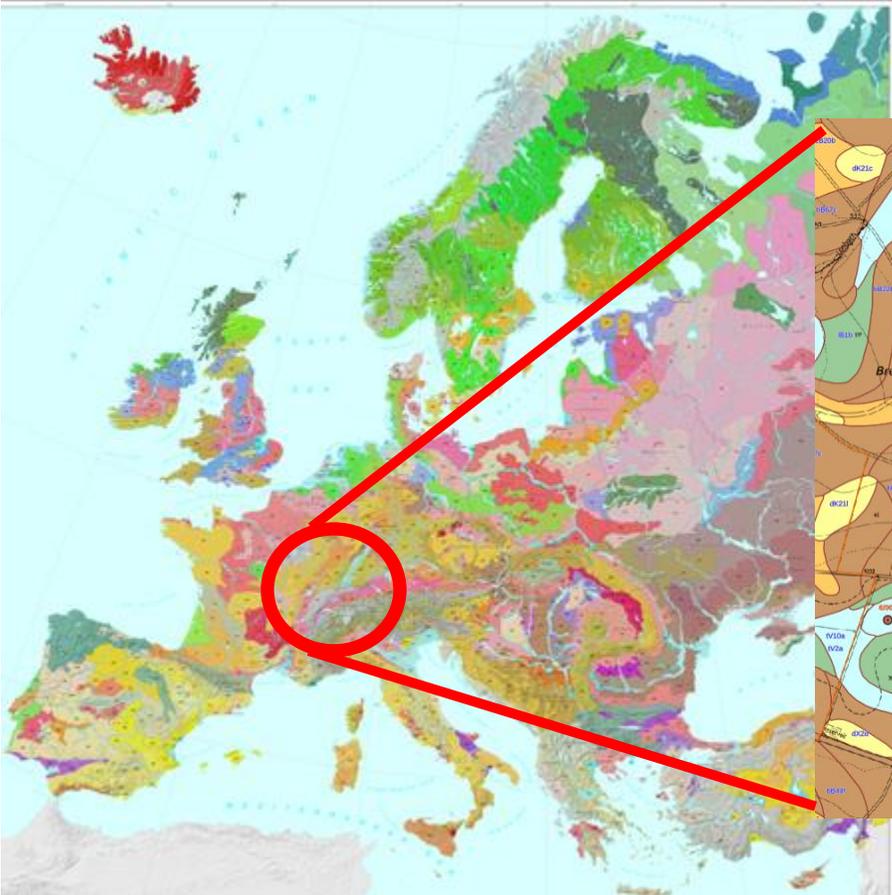
Monitoring Soil: trend detection



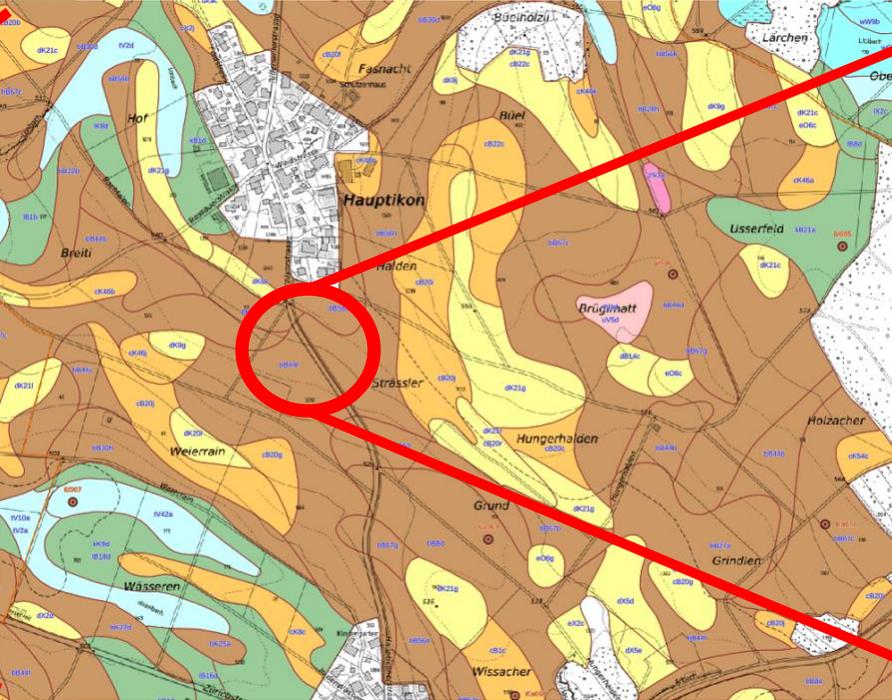
- ⇒ Required point density in-situ (challenging: increasing spatio/temporal resolutions required)
- ⇒ EO for regular updating/resampling



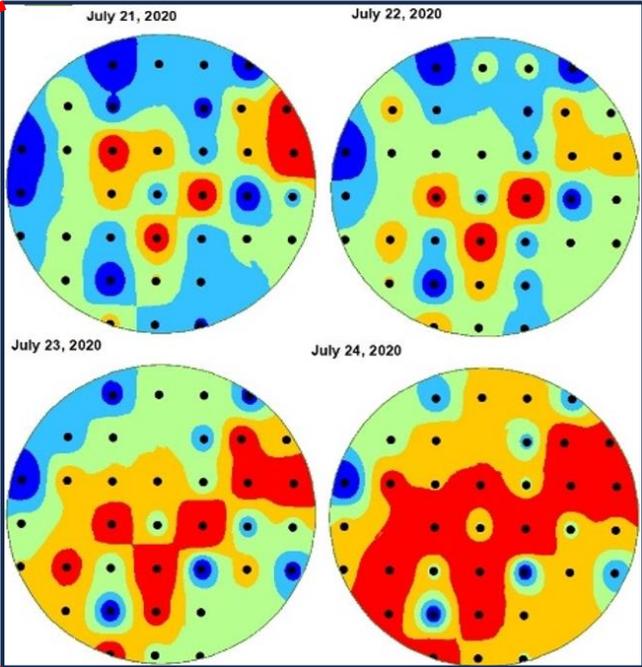
Spatial variability: challenge for soil monitoring



European soil regions map (BGR)



Local soil map Kanton Zuerich (GISZH)



Variability of soil moisture across the crop rooting zone under irrigation management.

Soil monitoring and EO: needs and priorities

soil moisture (current)

[SML: soil water storage and infiltration capacity]

texture

[1-off, in-situ subsamples only]

organic matter

Maturity EO methods, "high" frequency parameter

salinity

Accompanied by morphol. Processes: vegetation characteristics, surface hydrology, irrigation

soil erosion

Morphological features

soil crusting

(World)

Responsiveness of sampling: events, hot spots

nutrient levels

"High" frequency parameter;

pollution

large EO uncertainties

Soil

Temporal challenge

Spatial challenge

Technical challenge

Complexity of sampling and analysis

SML: Sampling and reporting: every 5 yrs

Monitoring efficiency and cost (in-situ/parameter-specific vs EO)

Landcover/ use



**(“near-”)future:
Region- and task-
specific hybrid in-situ
/ EO approaches**

- ⇒ Re-sampling intervals
- ⇒ adaptation of sampling and reporting
- ⇒ “homogeneous” units (sub-samples)
- ⇒ In-situ/EO-parameters, combinations
- ⇒ Uncertainties/validation



Soil monitoring in Europe — Indicators and thresholds for soil health assessments



Thank you



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