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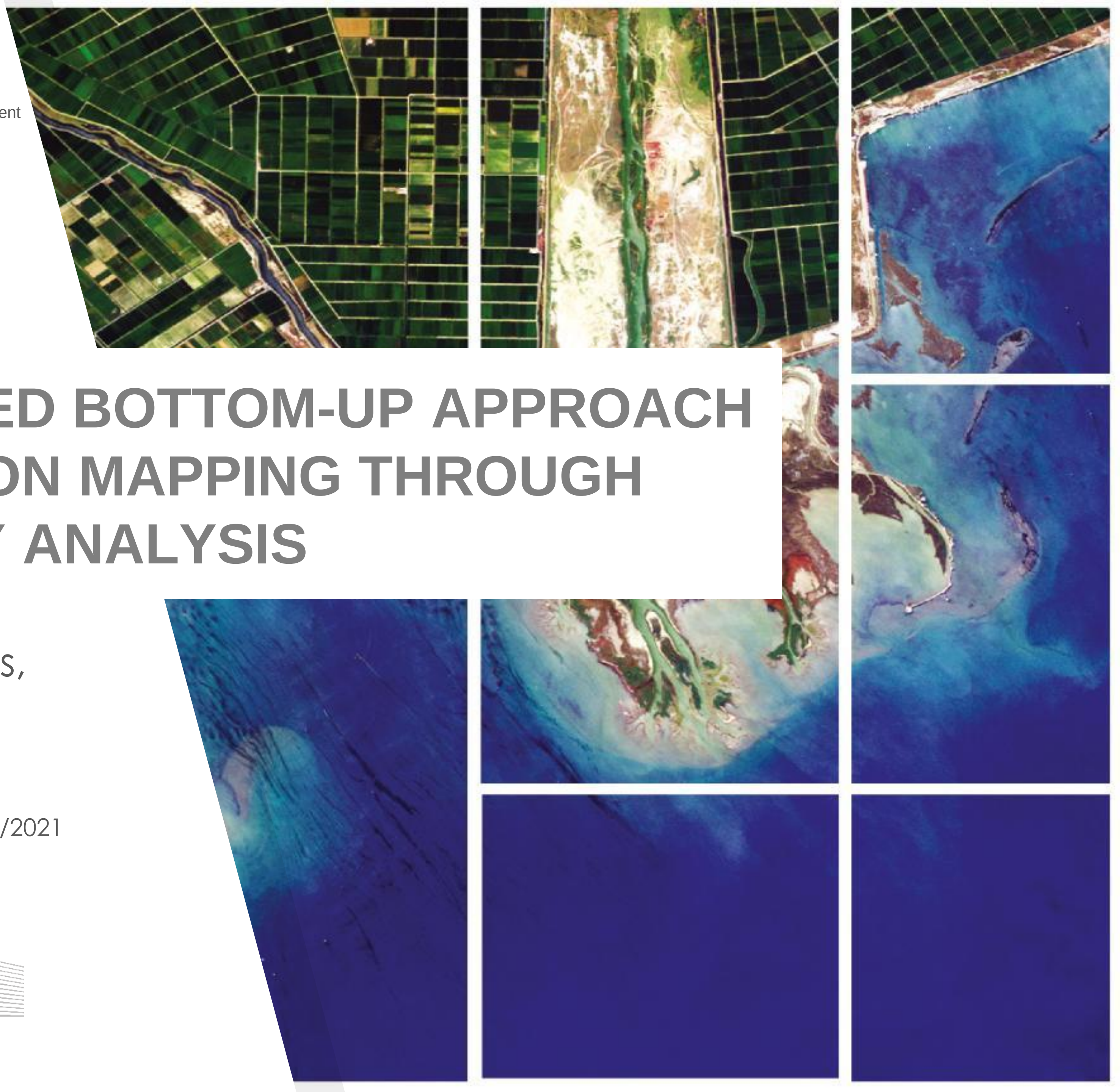

A CROWDSOURCING SPIKED BOTTOM-UP APPROACH FOR SOIL ORGANIC CARBON MAPPING THROUGH MULTISPECTRAL IMAGERY ANALYSIS

Konstantinos Karyotis, Nikolaos Tsakiridis, Nikolaos Tziolas and George Zalidis

EUSO Stakeholders Forum - Young Soil Researchers Forum, 21/09/2021

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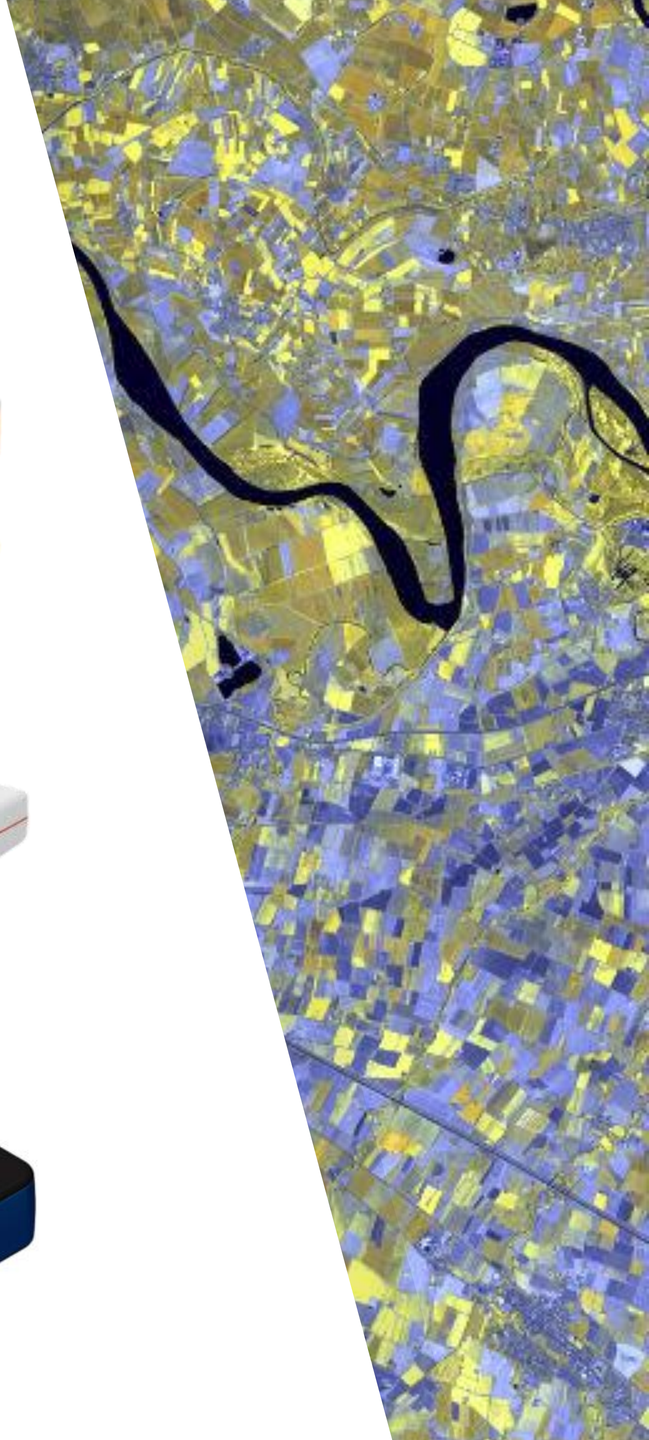
A few words about AUTH lab of RS

- Established at Thessaloniki, Greece, with many years of expertise in soil spectroscopy and Remote Sensing
- Member of various European and national research projects in the agri-food sector
- Fully equipped spectral lab:
  - Spectral Evolution PSR+3500 Vis-NIR-SWIR
  - Cubert Hyperspectral Video Camera FireflEYE V185 (Vis-NIR)
  - Spectral Engines S2.0 & S2.2 SWIR MEMS spectrometers (1500-1900 nm, 1750-2150 nm)
- Chemical lab
  - Soil and water analyses
  - GLOSOLAN regional champion



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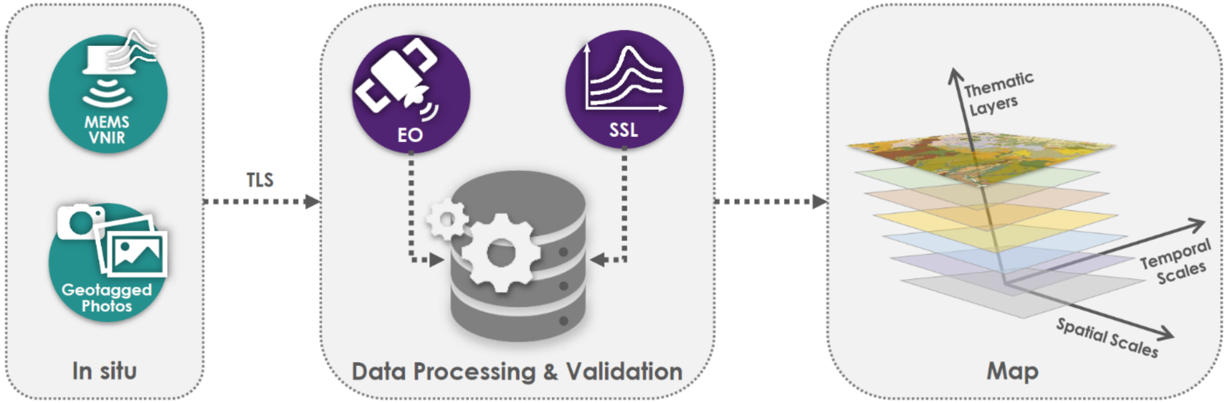
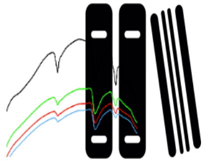
A few words about DIONE

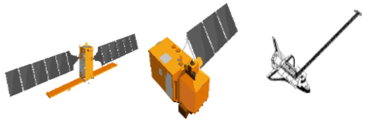
- H2020 funded
- Modernizing CAP – Providing tools for National Paying Agencies
  - “Bridging in situ with RS”
- Produce thematic soil maps through bottom-up approach – Convert point observations to digital soil maps



Proposed framework for deriving soil health indices

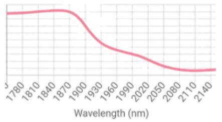


Soil Spectral Libraries

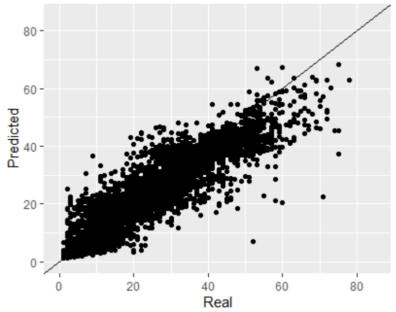


Earth Observation data

In situ spectral signatures



ML model

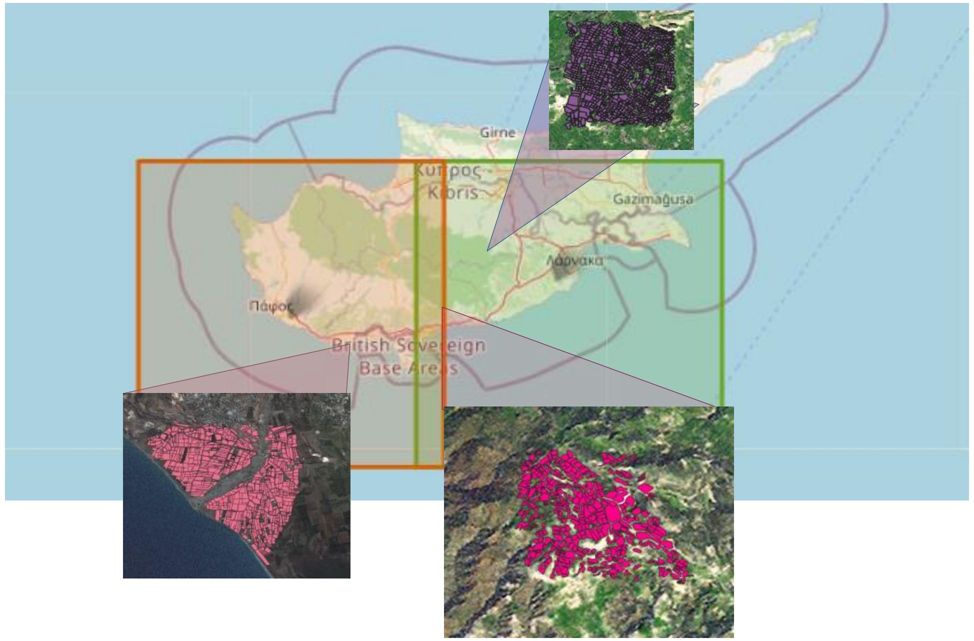


Soil health index

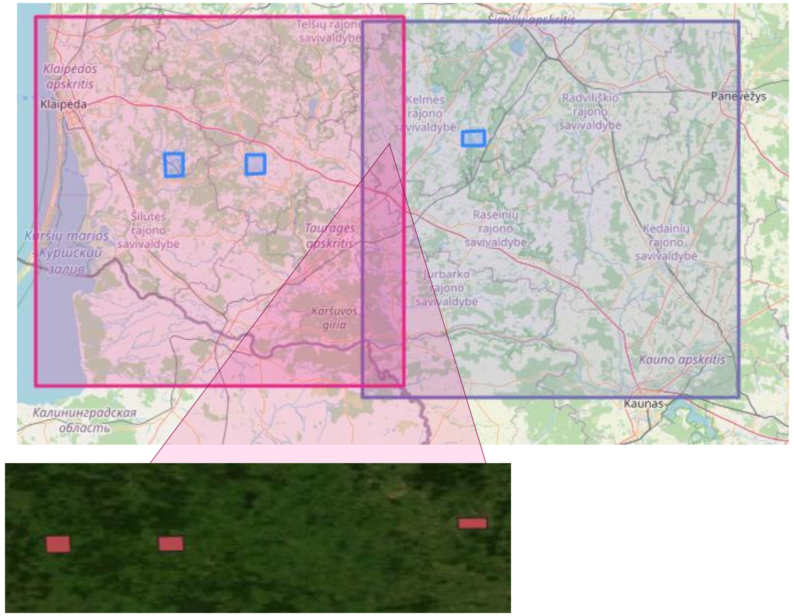
Soil Organic Matter content

- Open Soil Spectral Libraries:
  - LUCAS 2009 and 2015
  - GEO-Cradle – regional SSL of the south-eastern Mediterranean region
- EO data:
  - Sentinel-1, Sentinel-2, Landsat
  - Modis, SRTM-DEM
- In situ spectral signatures
  - MEMS low cost SWIR sensor

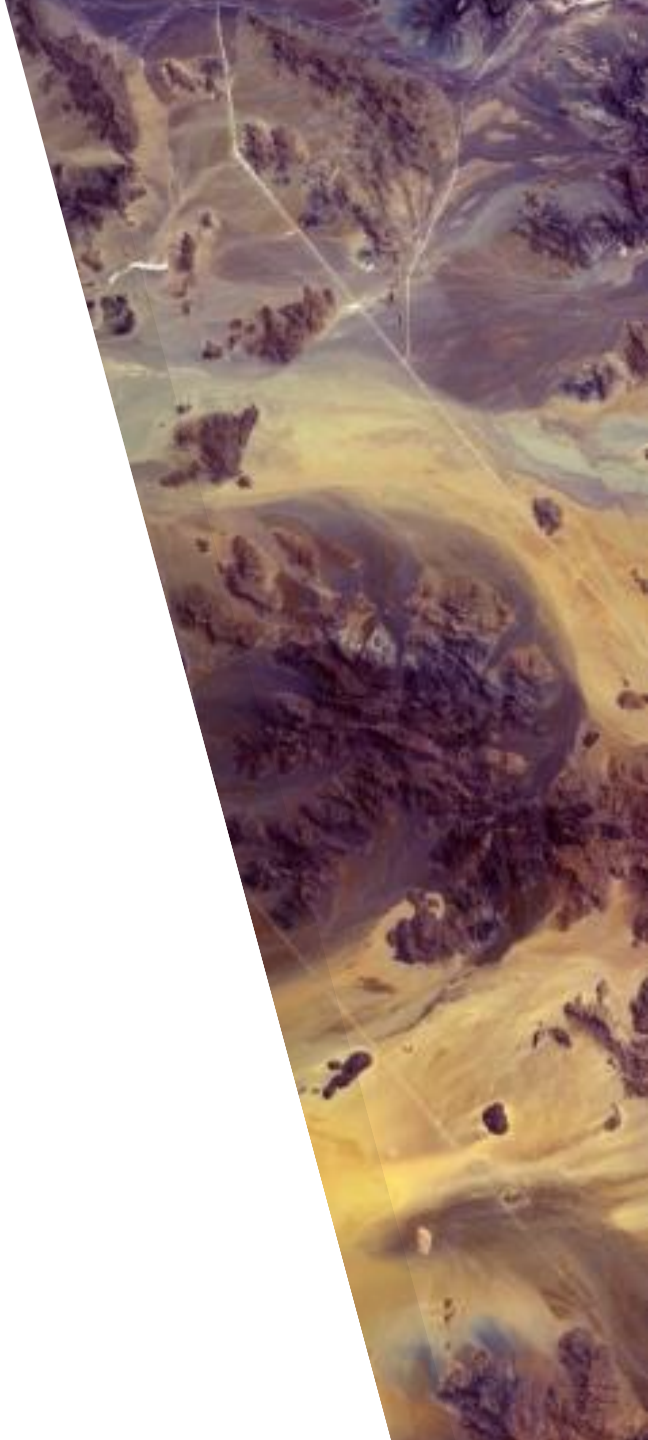
Study areas – Six regions with different soil characteristics



Cyprus: Total area 8.32km²



Lithuania: Total area 9.3km²



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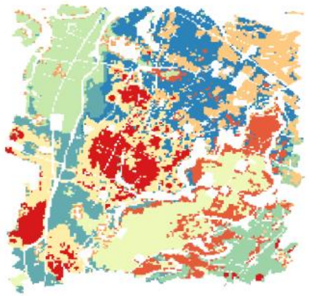
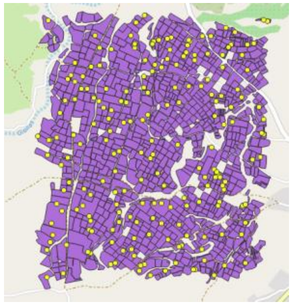
Study areas – Preliminary analysis (Agia Varvara - Cyprus)

- Preliminary analysis – Bare soil masking
  - Cube of Sentinel-2 observations over the pilot areas' extend (timeseries with length of 3 years)
  - Bare soil identification and masking[1] (NDVI, NBR2 and CORINE CLC)
- Point selection
  - Spectra based clustering (k-means clustering)
  - Dissimilarity selection[2] (Conditioned Latin Hypercube Selection[3] algorithm)

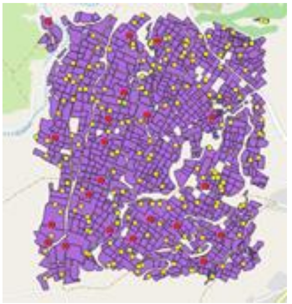
Bare soil recognition



Spectra based clustering



Points selection



Validation Points selection

40 validation points – Chemical analysis

160 unlabeled points – in situ SWIR measurements

[1]Demattê et al. 2009, Methodology for Bare Soil Detection and Discrimination by Landsat TM Image
[2]Castaldi et al. 2018, Sampling Strategies for Soil Property Mapping Using Multispectral Sentinel-2 and Hyperspectral EnMAP Satellite Data
[3]Minasny and Mcbratney 2006, A Conditioned Latin Hypercube Method for Sampling in the Presence of Ancillary Information

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Crowdsourcing and soil sampling

Red points: Scanned in situ with the MEMS sensor & a topsoil sample was analyzed for SOC content

Yellow points: Scanned in situ with the MEMS sensor only

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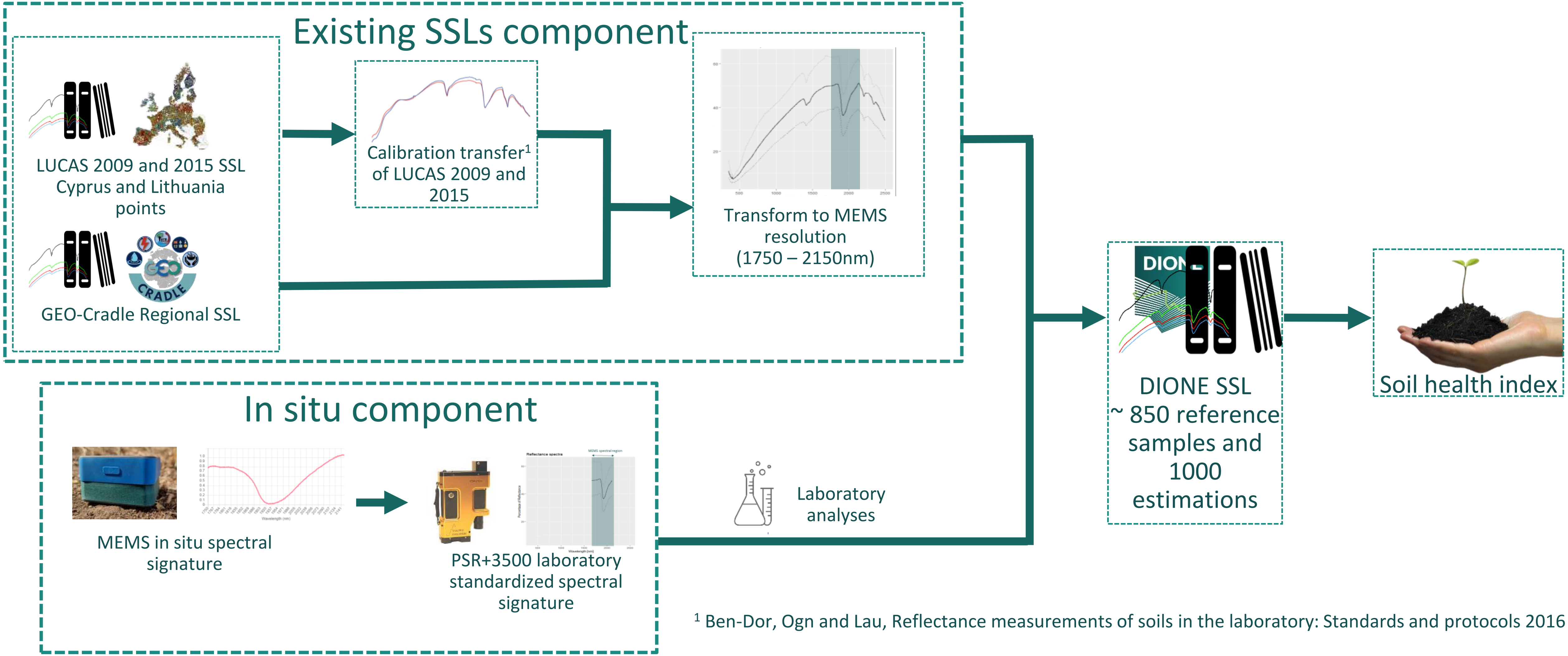
Combining existing SSLs with in situ reflectance data

Derivation of point estimations based on the analysis of MEMS spectral range (1750-2150nm)



[1] Ben-Dor, Ogn and Lau, Reflectance measurements of soils in the laboratory: Standards and protocols 2016

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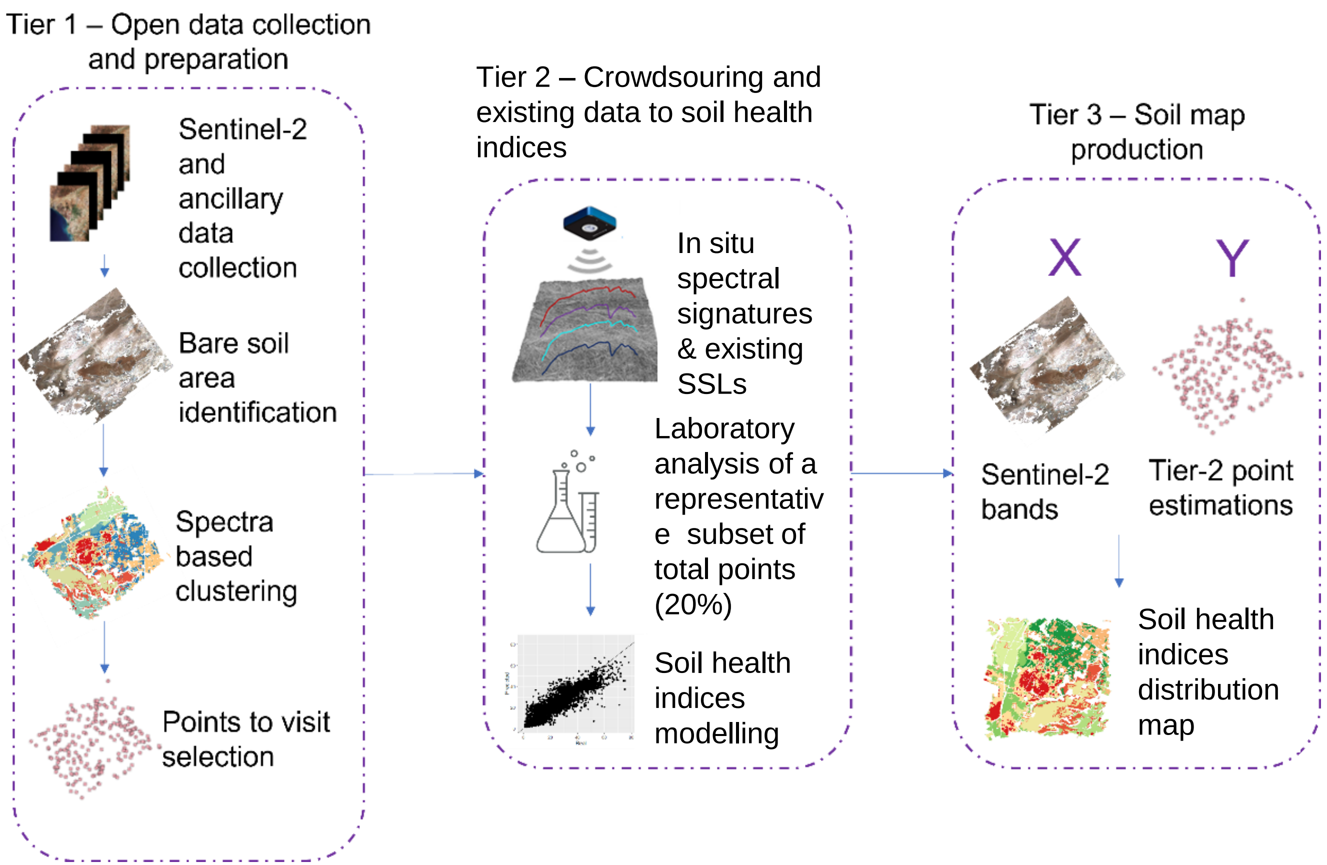
Spiked bottom-up approach overview

Spatially explicit soil indicators’ map production based on EO data



- Predict SOM over the point-locations that were selected at Tier 1
- Collect Multitemporal observations of EO sources over the DIONE SSL point locations (pilot area, LUCAS 2009 and Geo-Cradle)
- Fit deep learning calibration models to derive digital maps of spatially explicit soil quality indicators

Remarks

- All EO data used are openly accessible and can be substituted from other sources (i.e. satellite data with higher spectral, spatial or temporal resolution - Copernicus high priority candidate missions, PRISMA etc)
- The methodology employs low cost in situ sensors with high potential providing many alternatives
- Further to the production of soil maps, it provides a quick soil health assessment which can be used by:
  - farmers
  - inspectors from Paying Agencies
  - agronomists – consultants
- The combination of existing SSLs with newly created SSLs, highlights the need for a universal measuring protocol and a cross-device calibration transfer
  - All measurements were standardized with the usage of Willy Bay and Lucky Bay Soil standards and calibration transfer was applied to non-standardized used SSLs

Thank you!

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Find more about DIONE project at: https://dione-project.eu/