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Proximal soil sensing and site-specific reclamation

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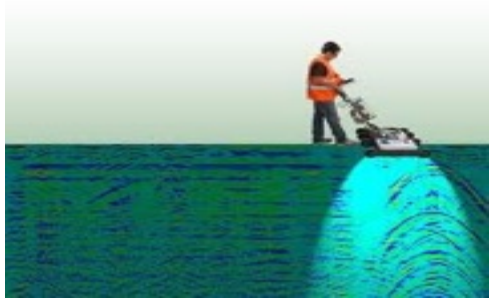
PROXIMAL SOIL SENSING FOR HIGH-RESOLUTION MAPPING

PSS includes field-based technologies for collecting information from close by, or within, the soil

PSS involves the use of geophysical, optical, and electro-chemical technologies



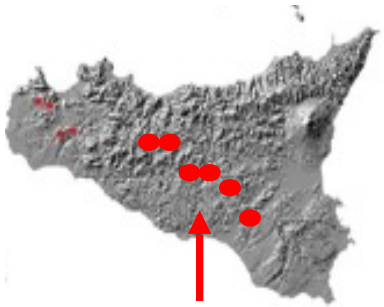
They provide thousands of data quickly and at low cost

GEOSTATISTICS ⇨ **HIGH-DETAILED MAPS OF SOIL SPATIAL VARIABILITY**

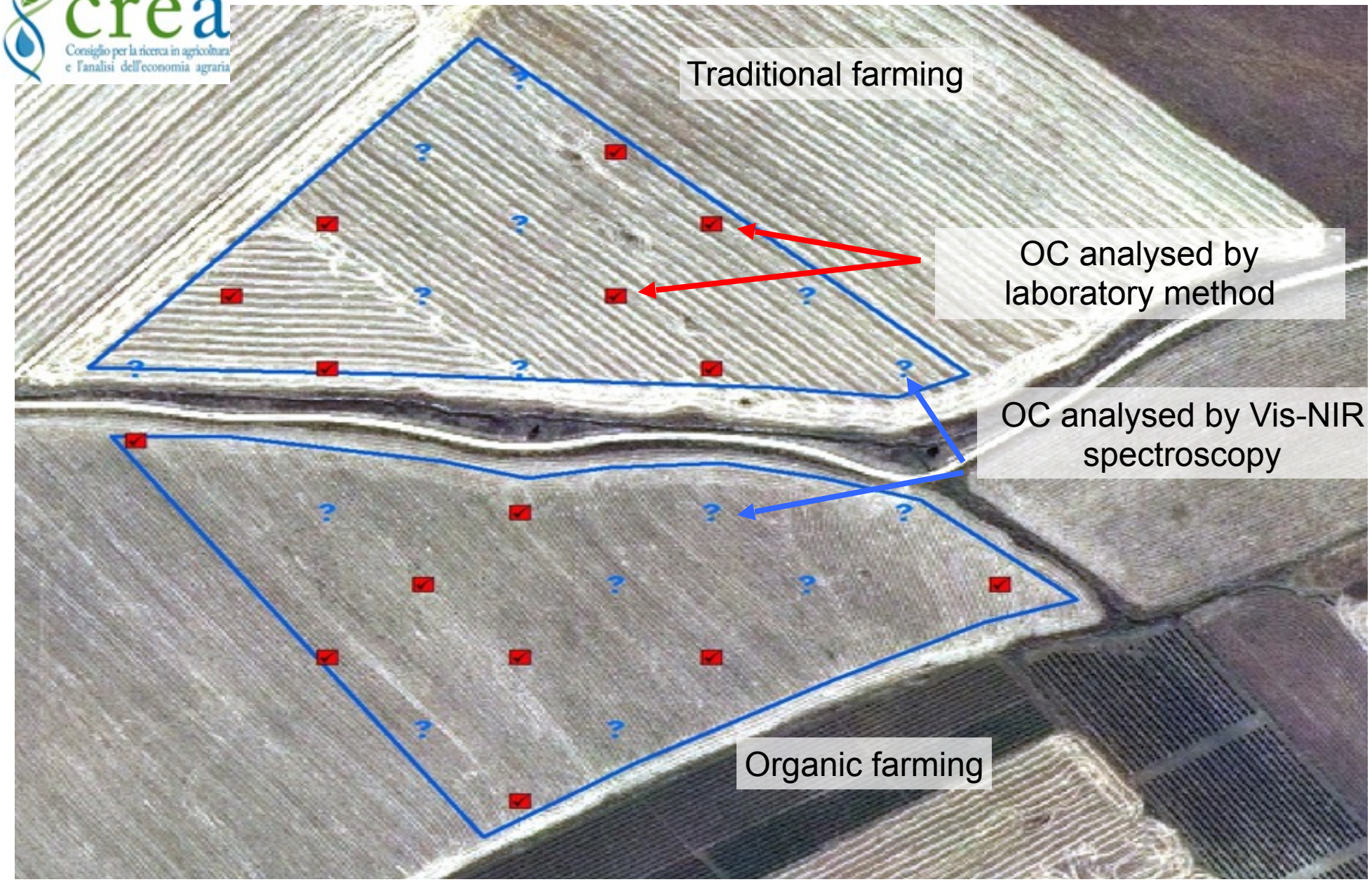
STUDY CASE 1: gamma-ray spectroscopy coupled with Vis-NIR spectroscopy to obtain high-detailed maps of carbon stock

STUDY AREA: western **Sicily,**

CROP: organic and conventional rotations with cereals



Experimental fields



- **20 fields surveyed**
- **220 samples collected (0-30 cm) and analysed by Vis-NIR**

SOC standard lab. Methods = 110

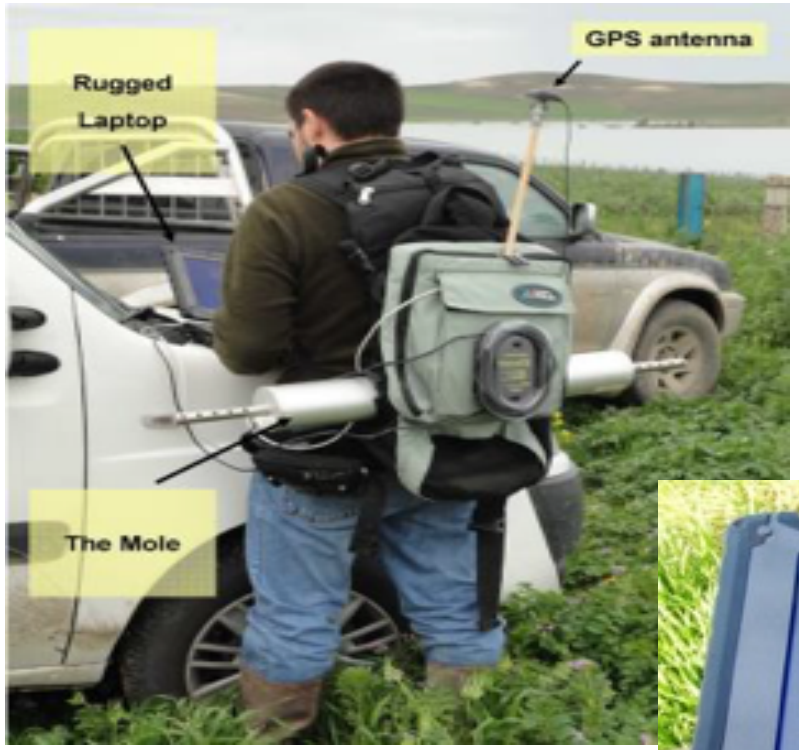
Bulk density in 3 samples / field

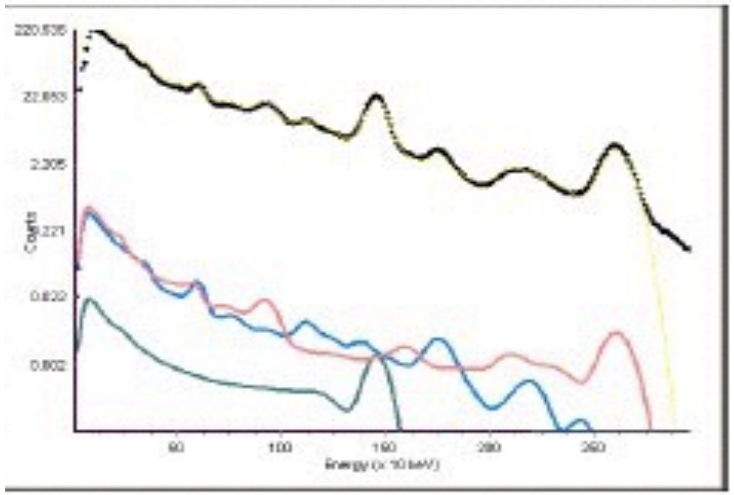
Average: about

5 sample/ha

CS = SOC x BD x (1-gravel content) x 0.30

Gamma-ray spectroscopy and soil sampling



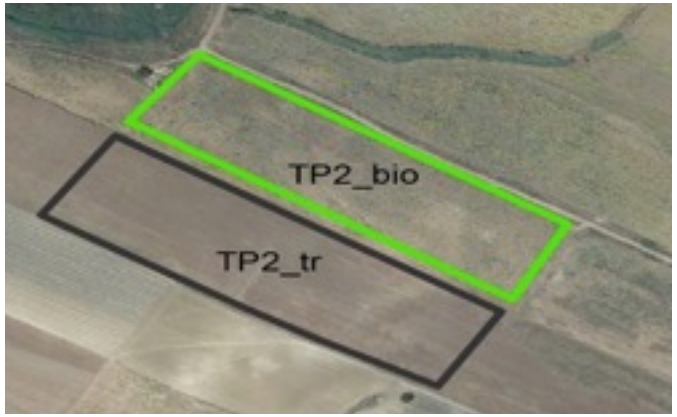


Total counts of gamma-rays emitted from the soil (about 0-40 cm)

Gamma-rays emitted from the radionuclides**:**
40K 238U 232Th

Gamma-rays are related to: parent material mineralogy, clay content, moisture, organic matter, stoniness, etc.

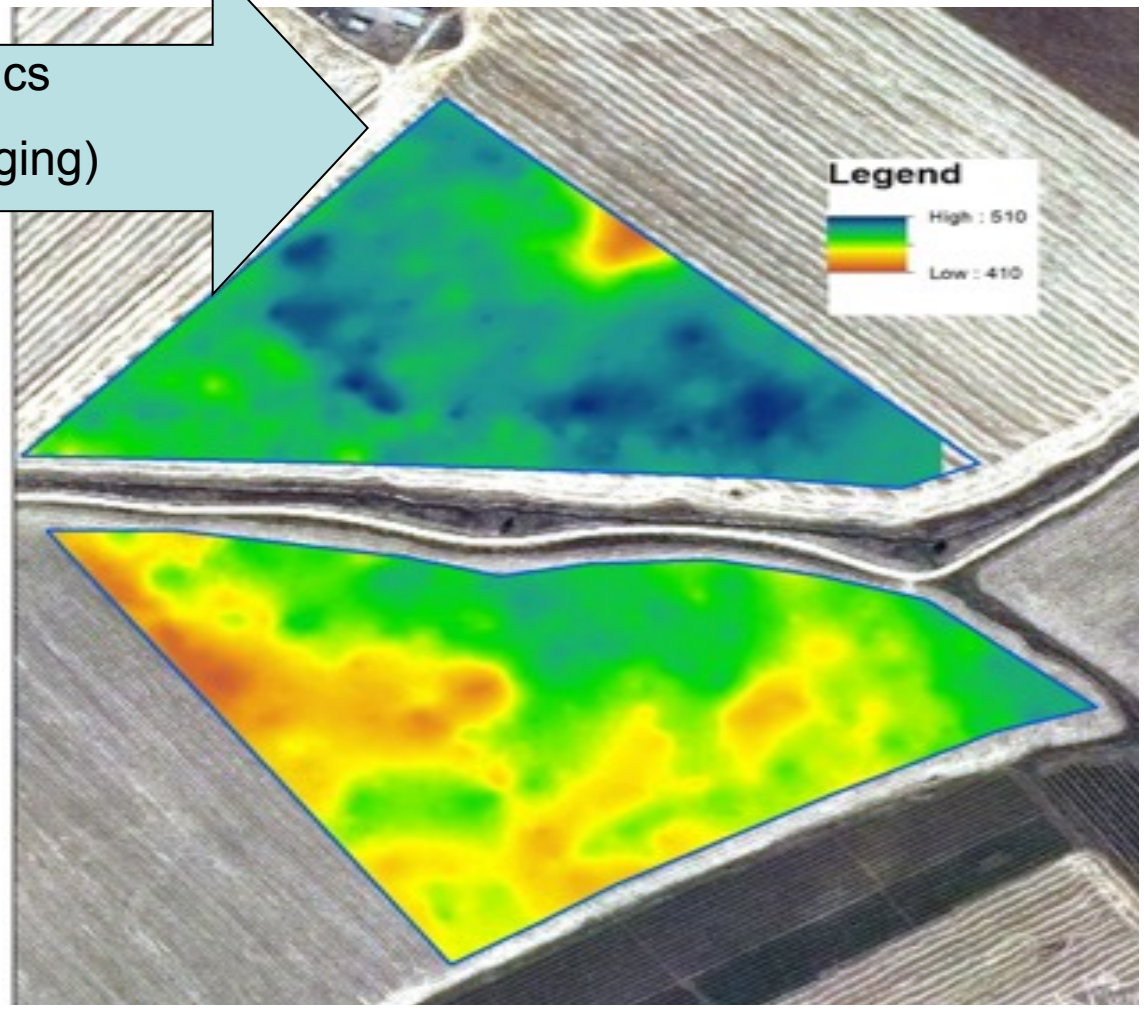
THE CORRELATION IS STRONGLY SITE SPECIFIC!



Gamma-rays total counts measured and interpolated

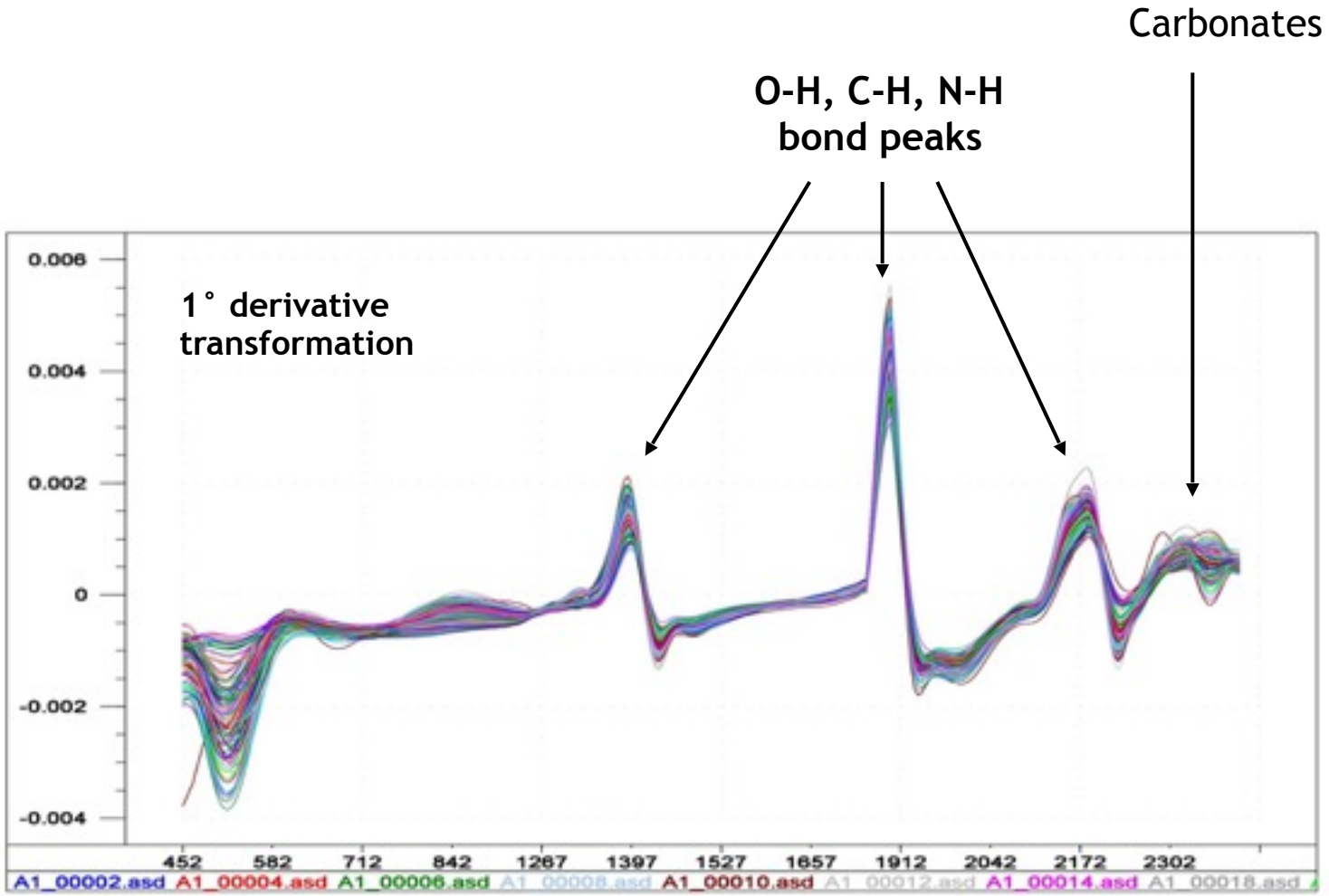
Geostatistics

(Ordinary kriging)

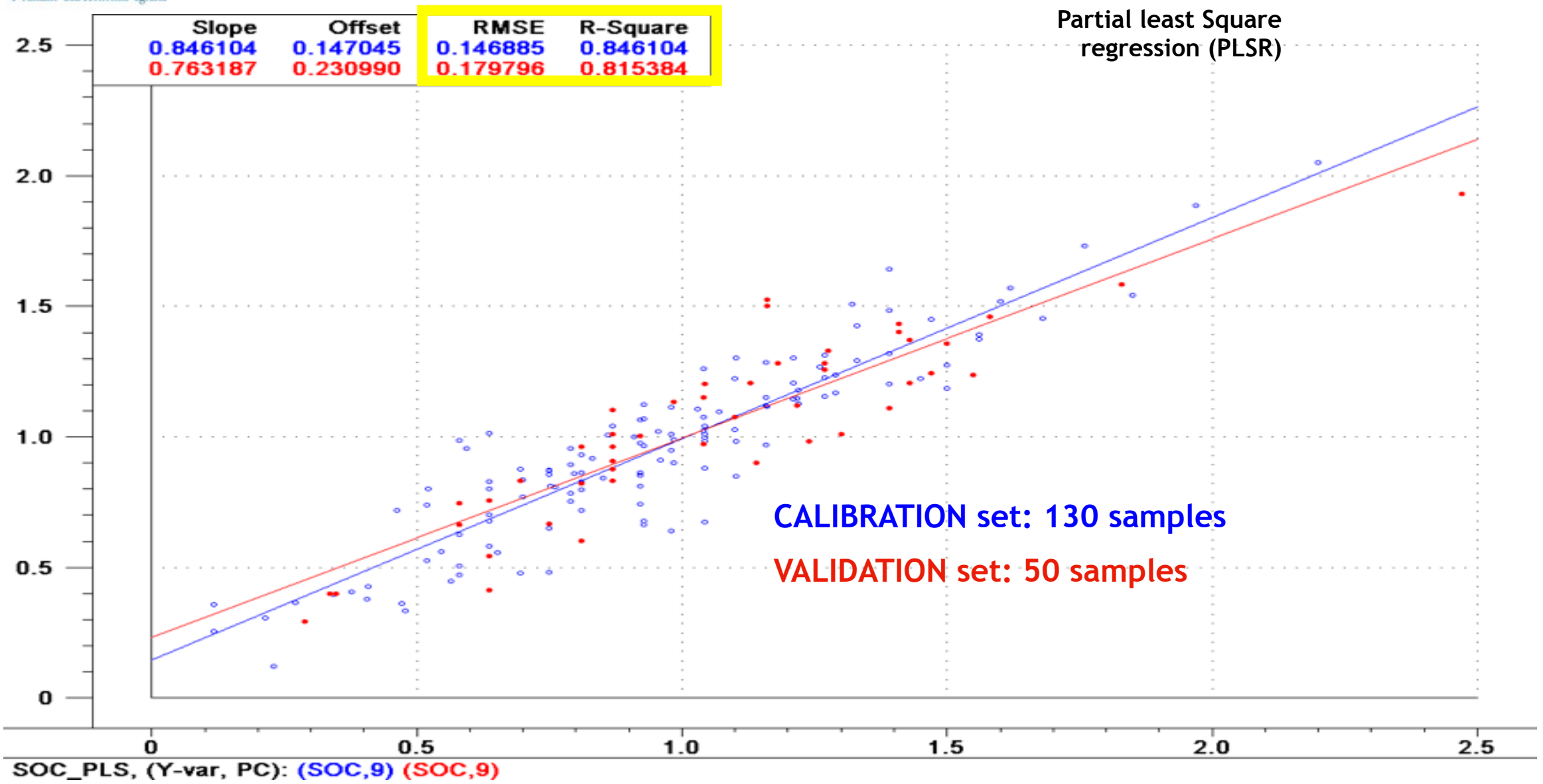


Vis-NIR spectroscopy (< 2 mm sieved)
visible (Vis 400-700 nm) and near infrared (NIR 700-2500 nm)

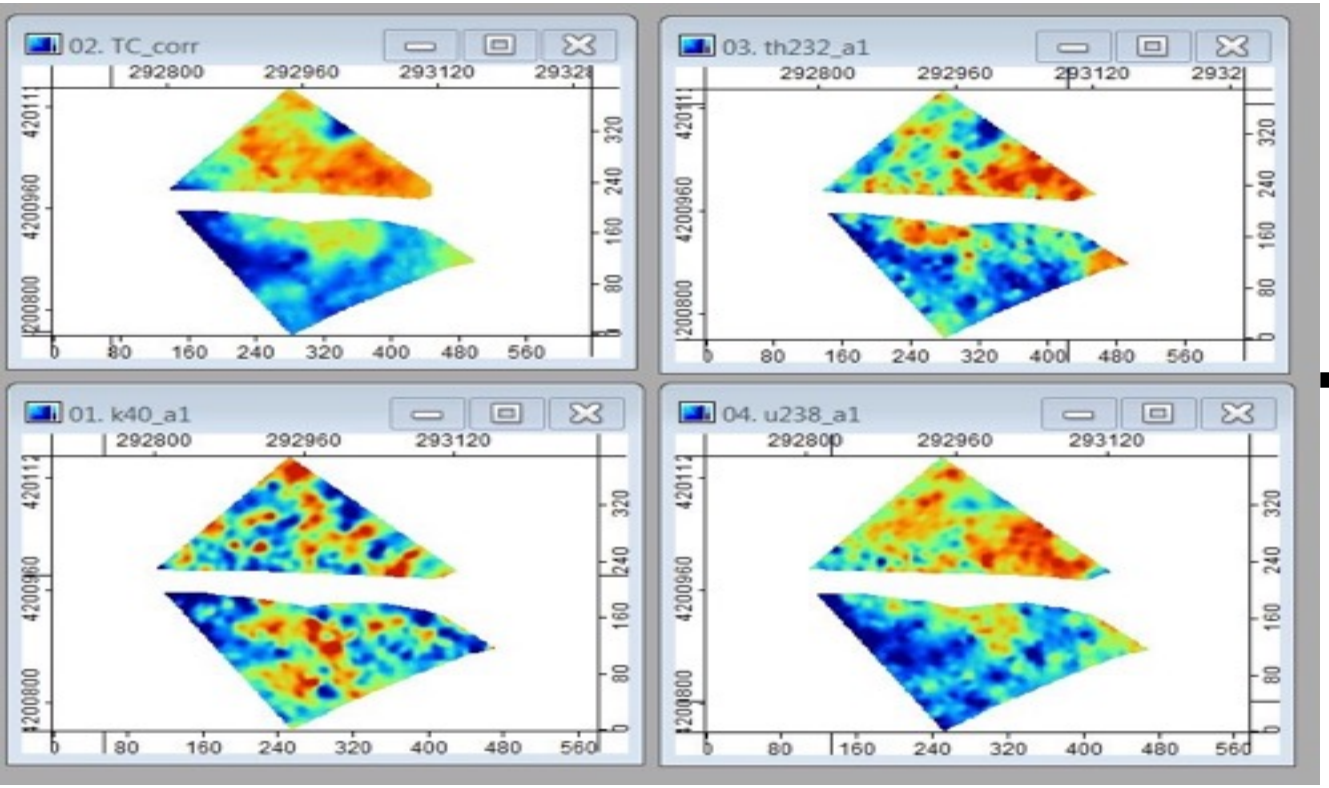
Quick and non-destructive analysis to predict several soil parameters (OC, clay, $CaCO_3$, CSC, iron oxides).



SOC prediction models of Vis-NIR calibrated on 180 samples (110 from the experimental fields + 70 CRA-spectral library)



Maps of gamma-ray data



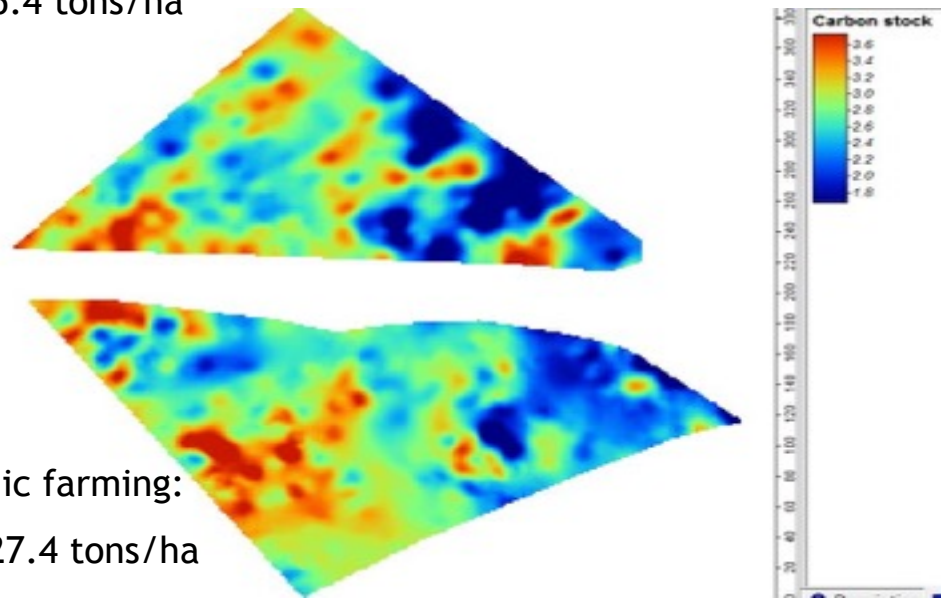
MAP OF CARBON STOCK (0-30 cm)

Conventional farming:

CS = 26.4 tons/ha

Organic farming:

CS = 27.4 tons/ha

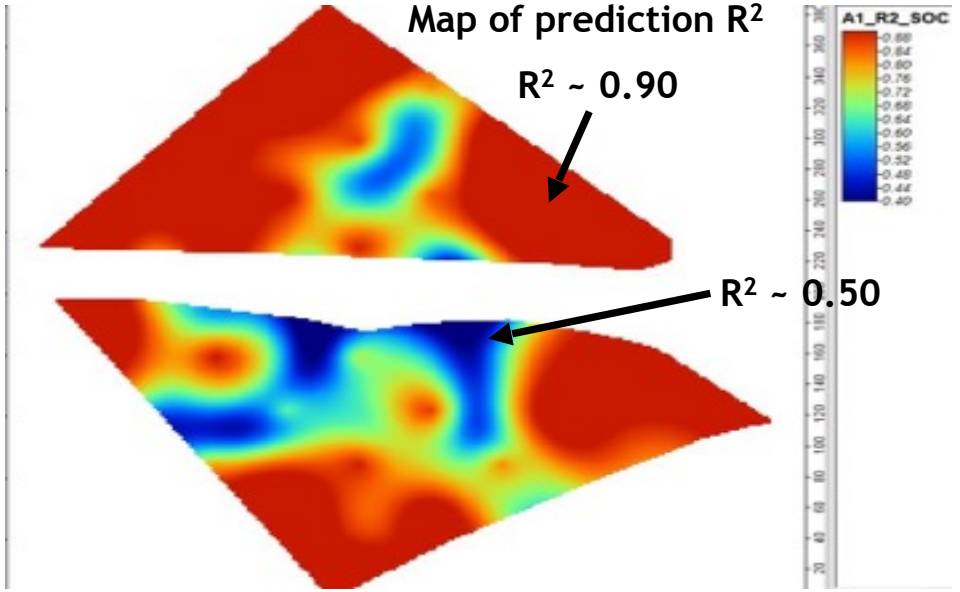


Geographical Weighted Multiple Regression (GWMR) γ-ray maps as dense covariate of SOC: multiple regression between CS data points and covariates, using a spatial weighting function - Gaussian spatial weighting model with a fixed bandwidth of 15 m

Map of prediction R^2

R^2 ~ 0.90

R^2 ~ 0.50



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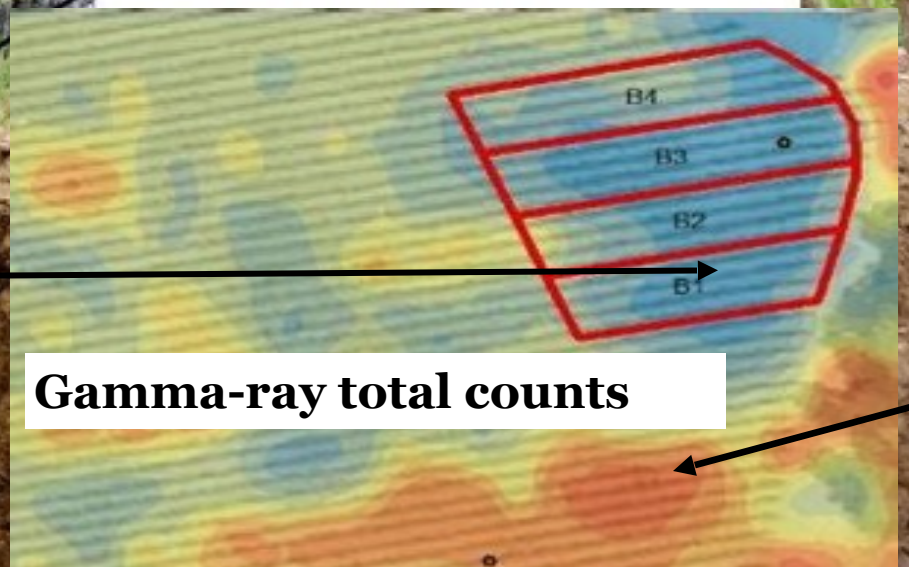
Deep land preparation for vineyard

Degraded area within a vineyard

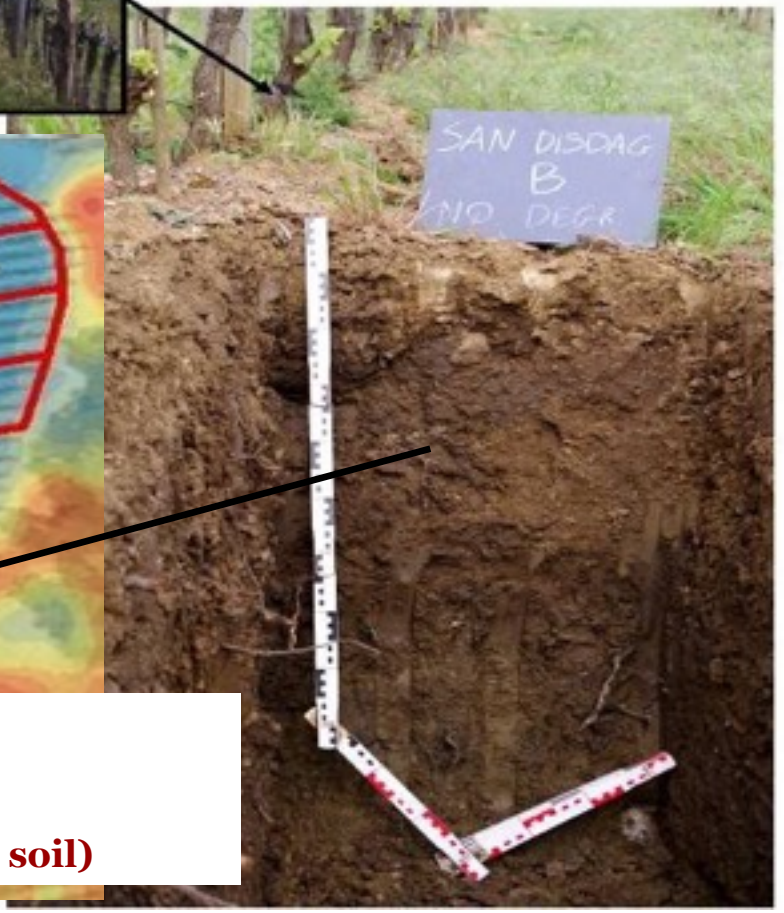
Exposed vine roots because of topsoil erosion

CASE STUDY 2: Mapping degraded soils in vineyards

Low grape yield and problems with vine growth



Gamma-ray total counts



BLU: 400-490 cont/sec

(eroded soil, calcareous, low fertility)

RED: 600-700 cont/sec (structured, preserved and fertile soil)

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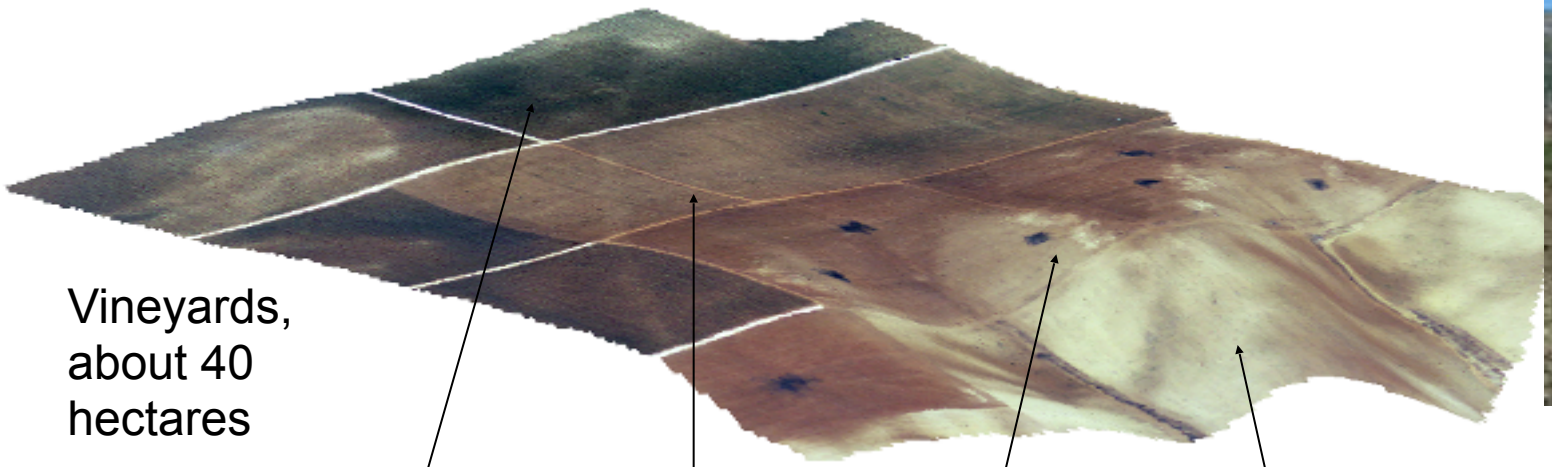
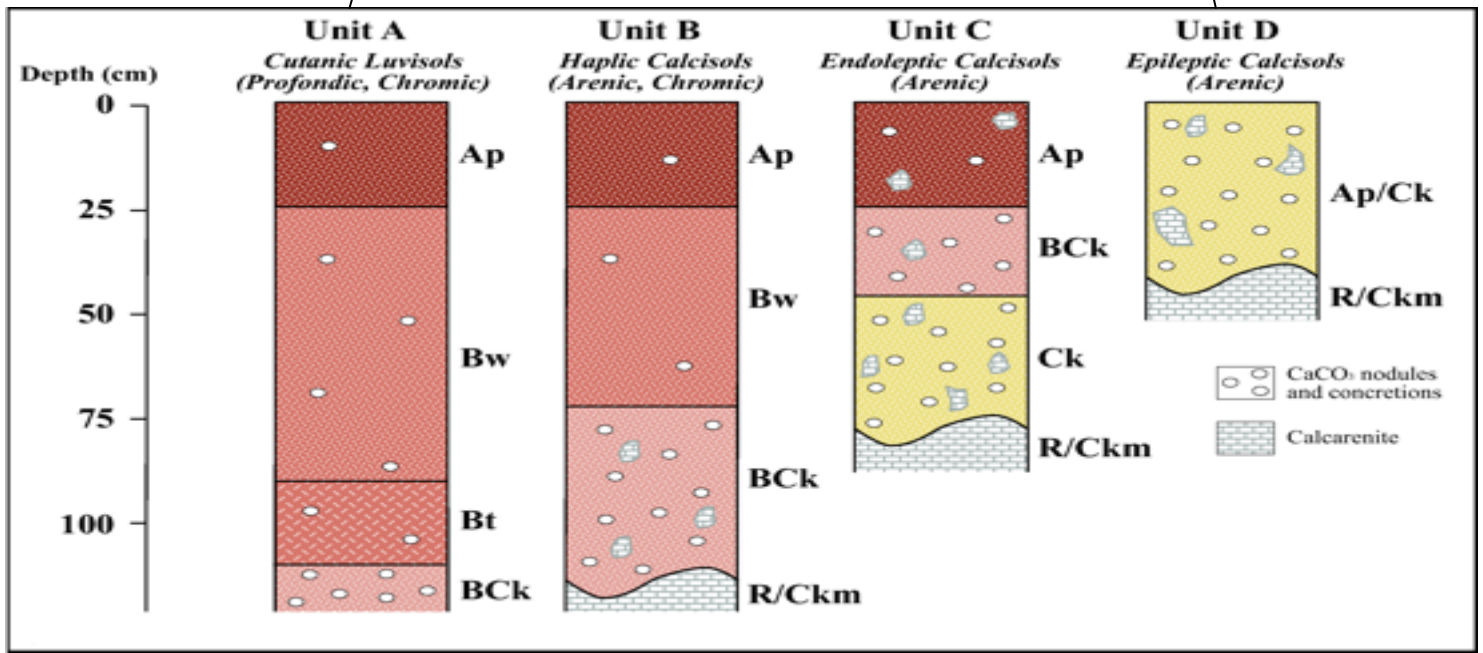
CASE STUDY 3: Mapping soil depth through georesistivimetre



Vineyards, about 40 hectares



Calcarenite marine terraces (Sicilia)

NDVI (satellite)

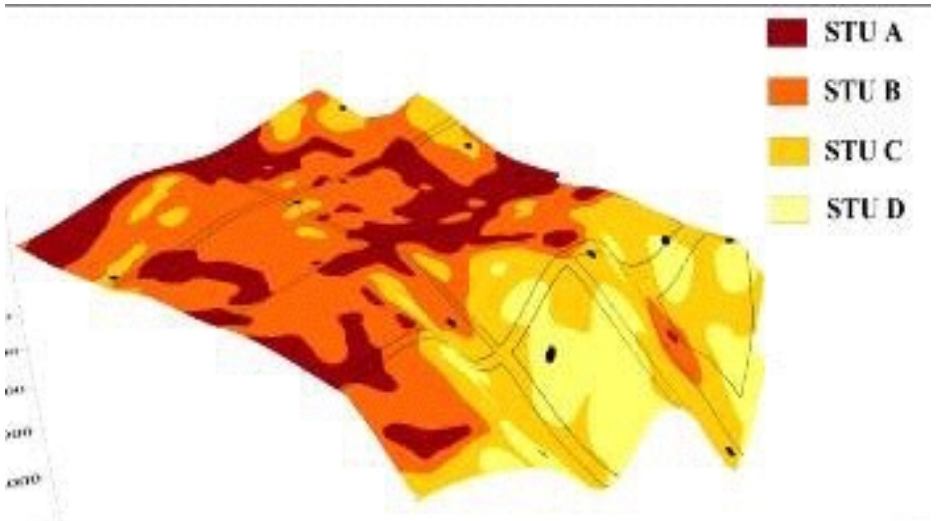
High vigour (NDVI)

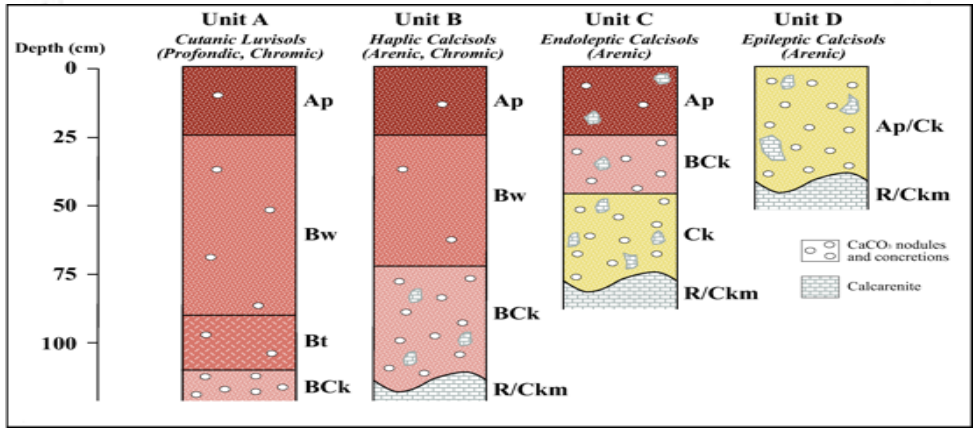
Mean vigour

Low vigour (stressed vines and low yield)

Soil depth

Electrical resistivity





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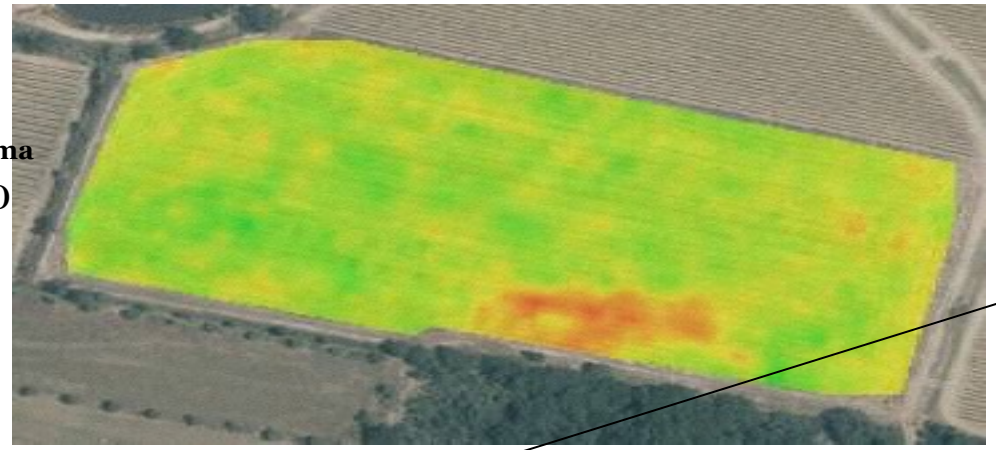
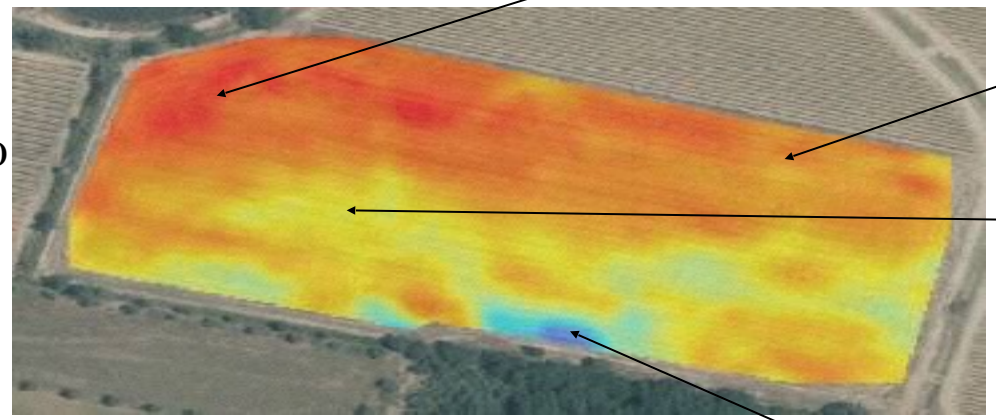
CASE STUDY 4 : project a new plantation
Drainage placement

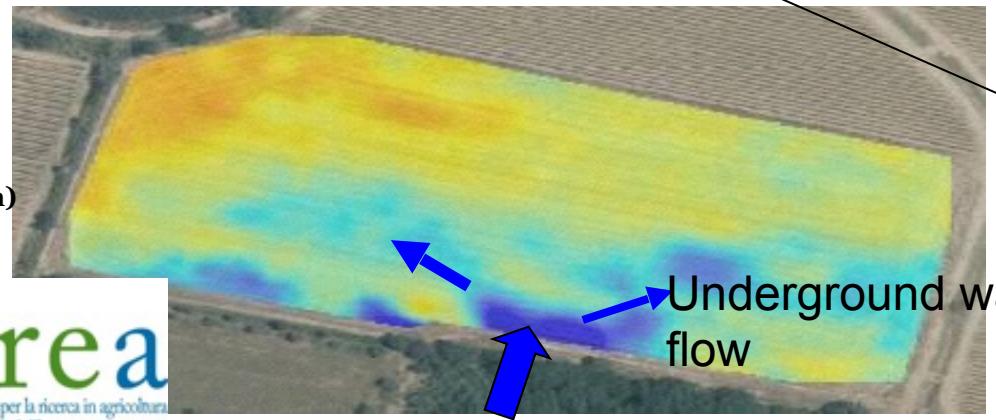
Cont_
raggi-gamma
(0-40 cm)



EC
(0-75 cm)



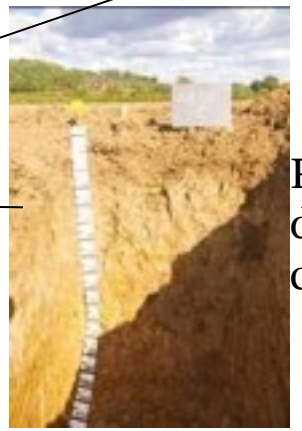
EC
(0-150 cm)



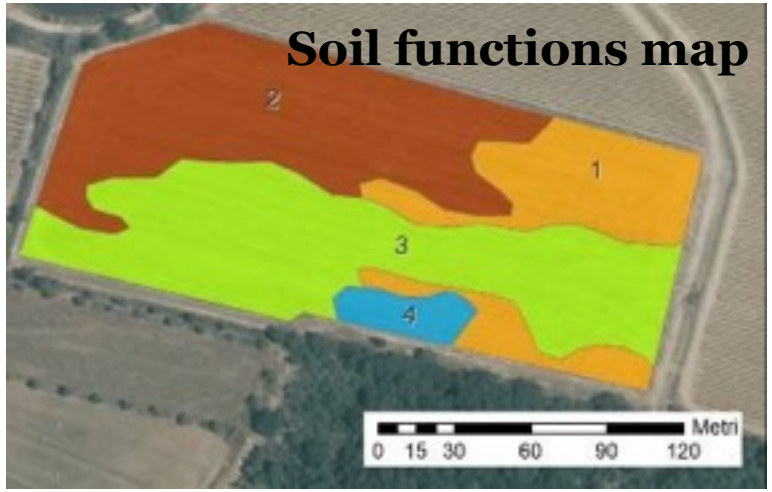
Underground water flow

Well drained sandy loam

Well drained clay loam, gravelly



Poorly drained clay loam



Poorly drained clay soil, compacted in depth, very calcareous, low fertility

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CONCLUSIONS

- There are some commercialy available proximal soil sensors which can improve notably the survey of soil variability at the very detailed scale

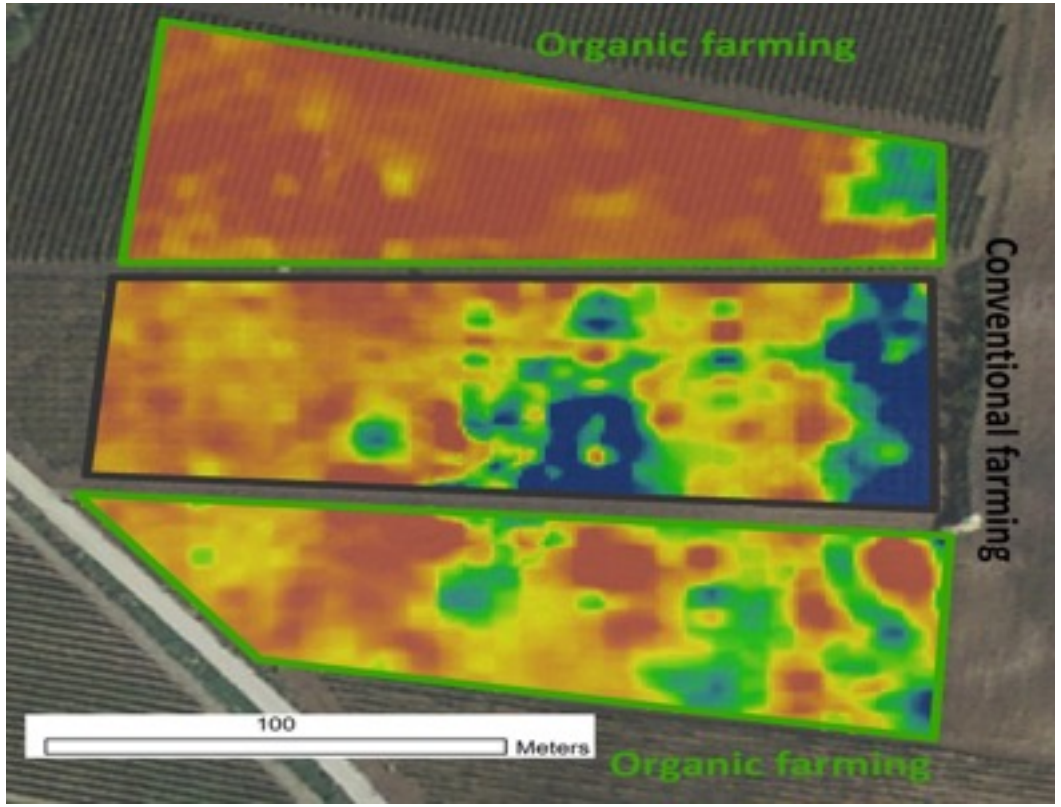
-The Vis-NIR reflectance spectroscopy is a quick and non-destructive method of soil analysis, which are alternative to complex and expensive traditional laboratory analytical method

-Future research perspectives:

-Better quantification of main soil properties, as well as quantification of available nutrients, pH, cation exchange capacity (CEC), and organic matter fractions.

- new PSS combining measurement of soil properties and spatialization:

direct mapping of soil quality



Thank you!

LIFE08 ENV/IT/000428

Soilpro: monitoring for soil protection

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