

Advancing soil moisture estimation across scales: insights from the SoMMet Project

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SoMMet project

Overall aim: to develop novel and **traceable** methods and establish a **metrological** infrastructure for soil moisture measurements covering **lateral scales** ranging from the decimeter to kilometer

Point-scale sensors **Cosmic-ray neutron sensing (CRNS)** **Satellite-based remote sensing**



Mobile TDR, www.specmeters.com



CRNS FINAPP, Bondeno



Sentinel-1 Copernicus

$(10^{-1} - 10^1) \text{ m}$

$(10^2 - 10^3) \text{ m}$

$(10^3 - 10^4) \text{ m}$

Specific questions: how to deal with SWC products with different

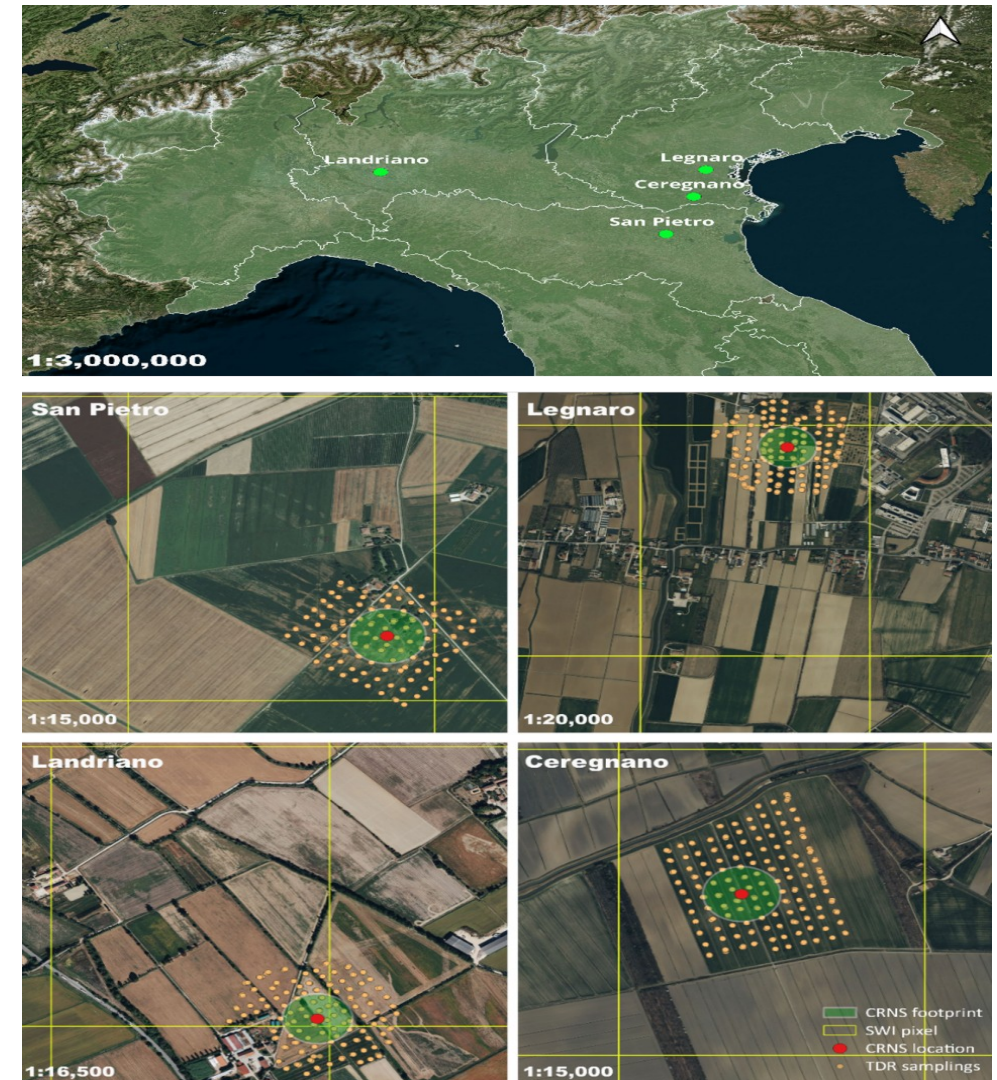
- Units
- Footprint/scale: horizontal and vertical
- Temporal resolutions



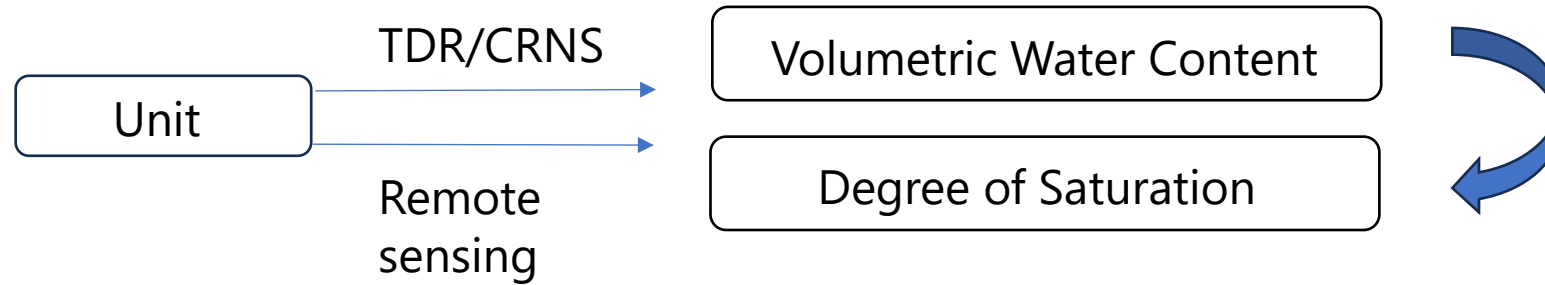
Harmonization and representativeness:
to make different measurements
comparable

Experiments and data collected

- Data collected at four sites, Northern Italy, 2021
- SWI by CGLS for 3 depths (T values)
- CRNS with radius of ~ 125 m
- Mobile TDR observations



First challenge: unit harmonization



$$\Phi = 1 - \frac{\rho_{bd}}{2.65} \quad (\text{Saxton \& Rawls, 2006})$$

$$\Theta = \frac{\theta - \theta_r}{\theta_s - \theta_r} \quad (\text{van Genuchten, 1980})$$

Assumptions:

- Residual soil moisture in VWC = 0
- Saturated soil moisture in VWC = porosity
- For 2 sites, **maximum** observed hourly CRNS VWC were higher than the porosity extracted by equation

Intercomparison between TDR, CRNS and RS (e.g., best and worst case)

For $T=2$,
 $R = 0.8$
 $\text{ubRMSD} = 10.35 \%SR$

For $T=2$,
 $R = 0.38$,
 $\text{ubRMSD} = 19.01 \%SR$

Overall (mean), $T=2$
 $R = 0.6$
 $\text{ubRMSD} = 14.90 \%SR$

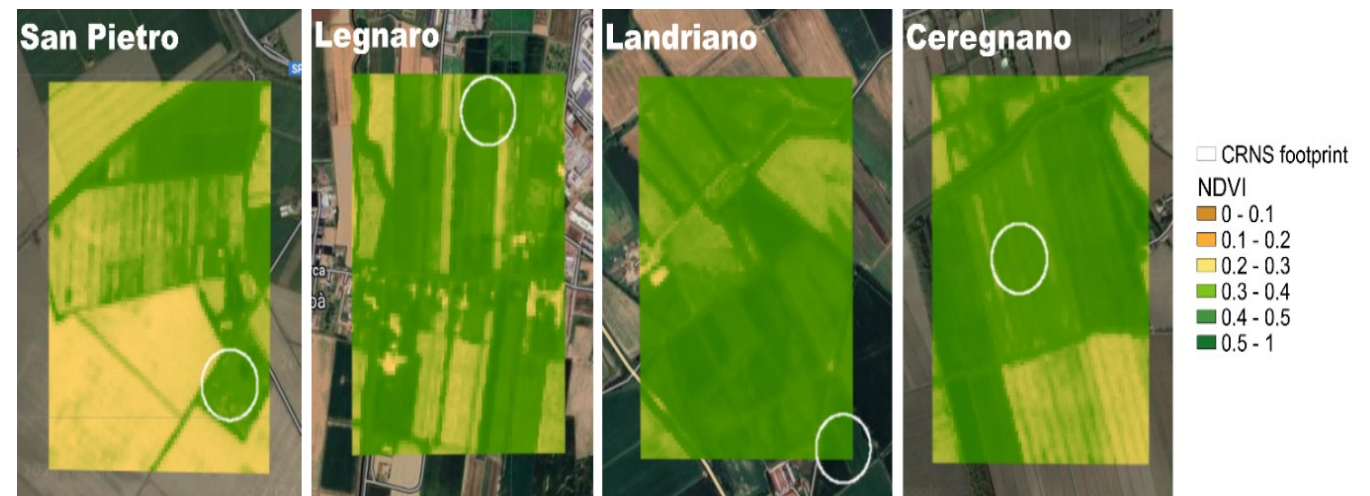


Why different results? Spatial representativeness

- The spatial variability of soil water content is driven by several factors like topography, atmospheric conditions, vegetation, and soil properties (Crow et al., 2012)
- Areas investigated in the present study are relatively small and flat

1. Vegetation (NDVI)

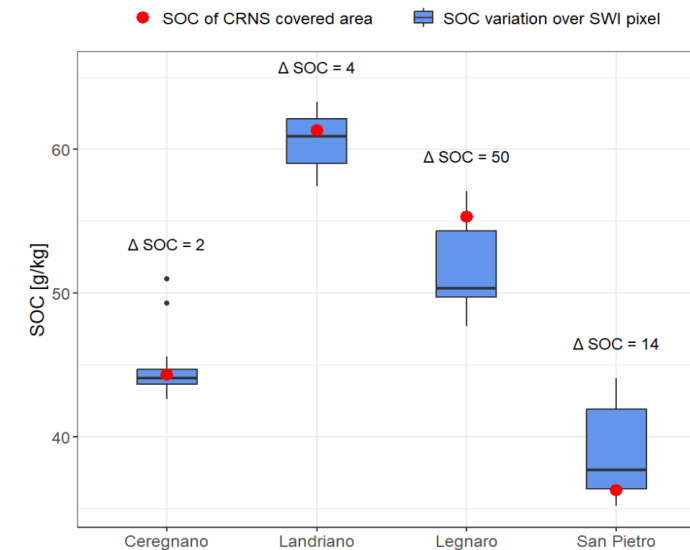
- Seasonal ubRMSD vs Δ NDVI
- Mean $R = 0.35$ ($T=10$)
- The ranking is completely **reversed** considering the grading of R we had when comparing SWC products
- Cases with higher disparities in SWC products, the discrepancy tends to be more related to NDVI alterations



Spatial representativeness

2. Soil

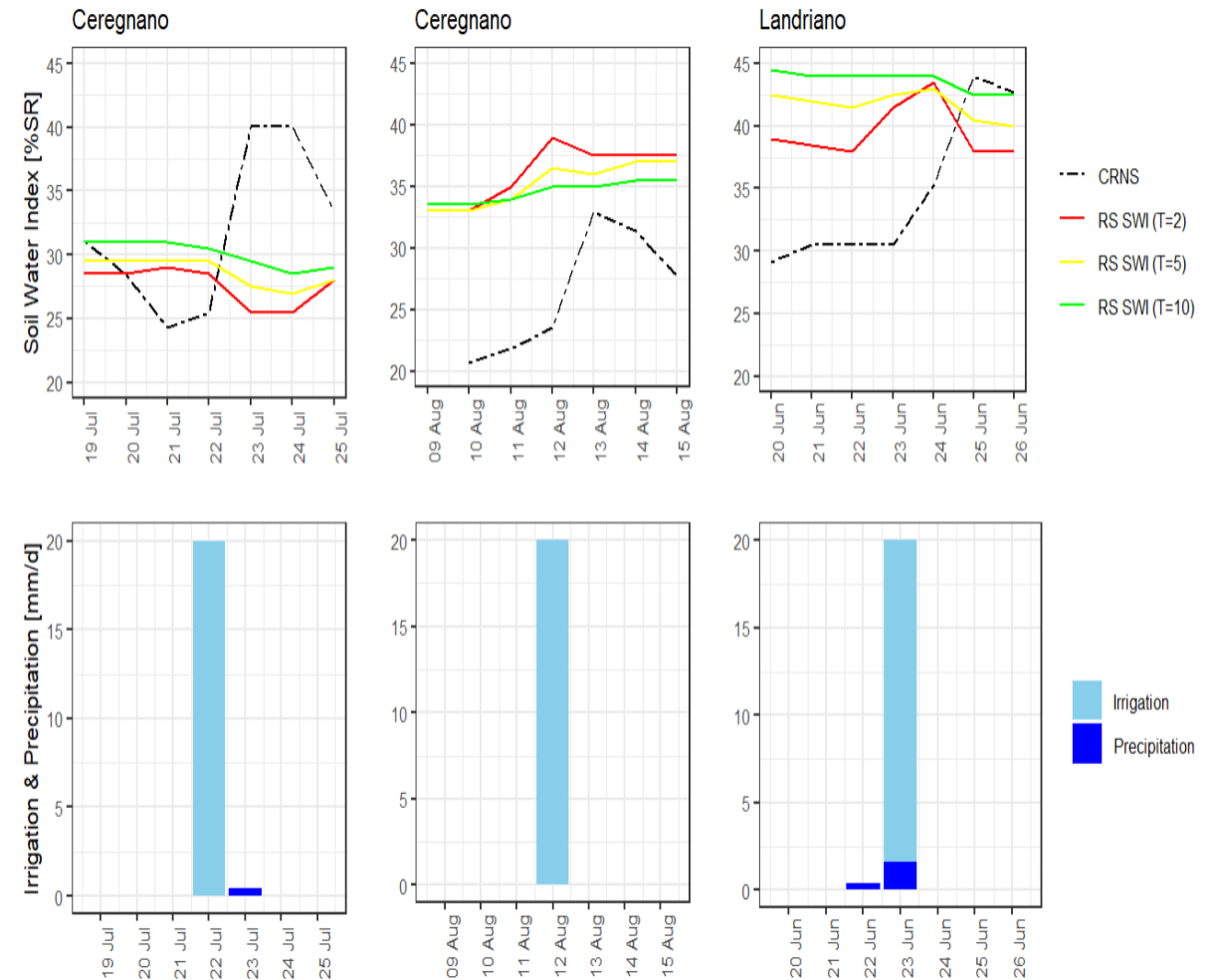
- SoilGrids (Sand, Silt, Clay, SOC) maps
- These differences do not relate with the performance ranking
- Less variation within RS pixel → better performance when comparing SWC products
- Loam type performed better



Spatial representativeness

3. Irrigation

- Effect on CRNS signal $> 10\%SR$
- Effect on RS signal $\sim 5\%SR$
- The irrigation events recorded at the CRNS footprint could also **not well represent** the RS-resolution
- **Need of information** about irrigation amount and date in neighboring areas within the RS pixels

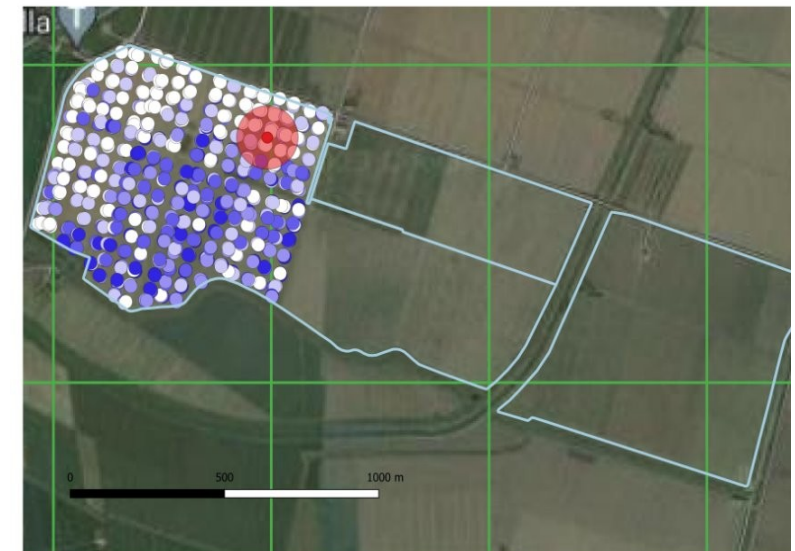


Objectives for the rest of the project

- **Deal with SWC products with different**
 - Units
 - Footprint: horizontal and vertical
 - Temporal
- **Comparison** of observation methods, their constraints and different spatial and temporal characteristics
- Apply and test various **harmonization** approaches
- Assessing strength and weakness of different harmonization approaches
- Development of the harmonization approach



<https://www.sommet-project.eu/project/test-field-sites>



SWC variability, Bondeno, Italy

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