Framework for a near-surface soil sampling survey and C-band SAR-based soil moisture mapping in the Alento terrestrial observatory, South Italy

Sarah Schönbrodt-Stitt (1), Paolo Nasta (2), Markus Kurtenbach (1), Nima Ahmadian (1), Nunzio Romano (2), Christopher Conrad (1,3)

(1) Department of Remote Sensing, Institute of Geography and Geology, University of Würzburg, Würzburg, Germany, (2) Department of Agricultural Sciences, AFBE Division, University of Naples Federico II, Portici (Napoli), Italy, (3) Institute of Geosciences and Geography, University of Halle-Wittenberg, Halle, Germany

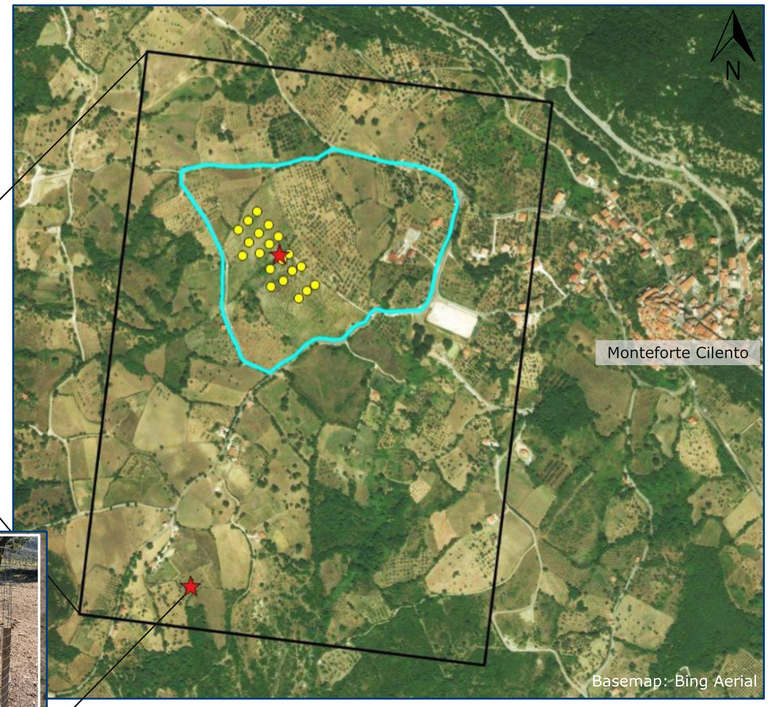
sarah.schoenbrodt-stitt@uni-wuerzburg.de, paolo.nasta@unina.it

Spatially explicit soil moisture (***θ***) information in a high temporal resolution plays an essential role in environmental modeling for improving risk assessment, for quantifying the effects of rainfall seasonality and climatic variability, and for addressing ecosystem services. Remote sensing data, particularly from the Copernicus mission is highly acknowledged to serve as a fast and available supplier for the derivation of area wide and high-resolution spatial-temporal information. To reliably estimate near-surface soil moisture patterns based on remote sensing, robust ground-truthing for cal/val procedures is required.

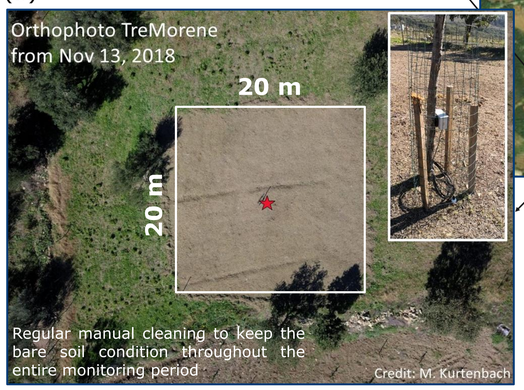
Study site

Alento terrestrial observatory within the TERENO

(TERrestrial ENvironmental Observatories) network across the Mediterranean region[1]



(b)



- SoilNet wireless sensor network
- Near-surface soil moisture monitoring stations
- MFC2 pilot agricultural field (~ 20 ha)
- Investigation site in Alento terrestrial observatory (~ 118 ha)

Station	X (UTM 33N)	Y (UTM 33N)	Altitude (m a.s.l., DEM 5 m)	Slope angle (°, DEM 5 m)
MFC2	515606	4468329	432.3	9.6
TreMorene	515404	4467589	351.9	17.1

Monitoring

- Monitoring at agricultural plot MFC2 (a) and at bare soil plot (b) TreMorene (reference plot)
- Parameters at 0-5 cm depth: θ (%), soil temperature (°C), electrical conductivity (Sm^{-1}), dielectric constant, recording time is 1 min
- Period from Nov 08, 2018 – Mar 28, 2019 (141 days)
- Mobile θ measuring campaign at 20 SoilNet plots in MFC2 during satellite overpasses of Sentinel-1 A/B (04:58-05:06 am, 04:51-05:04 p.m.), period Nov 10-28, 2018

Sampling

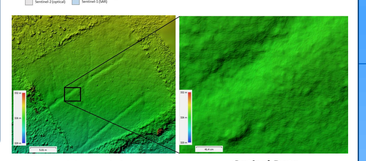
- Volumetric soil water content for sensor calibration at satellite overpasses
- Vegetation properties (e.g., LAI, vegetation cover at days of satellite overpass
- Soil properties (e.g., texture, bulk density, C_{org})

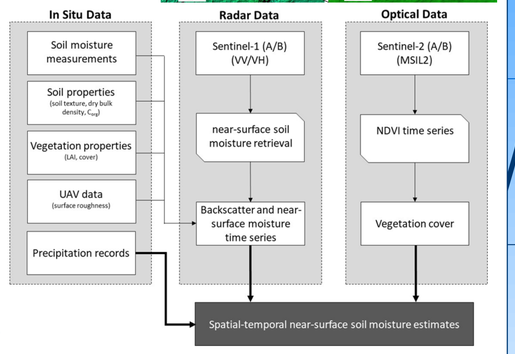
Database

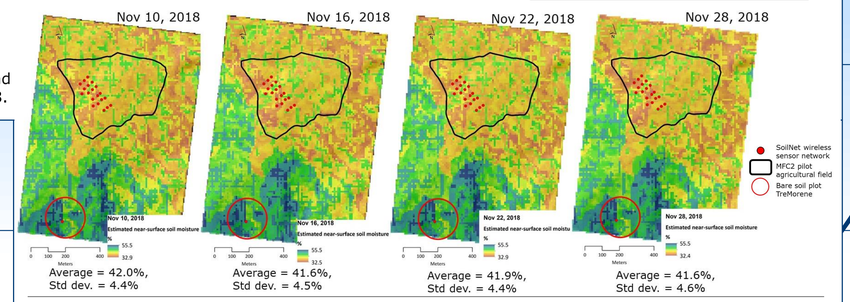
- Radar data Sentinel-1 (A/B) SLC, IW, HH/VH, 24 satellite overpasses during observation period
- Optical data Sentinel-2 A/B (MSIL2A), 8 cloud-free images (i.e., NDVI)
- UAV orthophotos (i.e., soil surface roughness)
- Climate data (i.e., precipitation)

Analysis

- To estimate θ by means of environmental covariates
- To test different mapping approaches (e.g., Water Cloud model, Random Forest, Gaussian Process Regression)
- To develop a workflow on deriving time series of θ in a high spatial-temporal resolution (~ 20 m, 6 d)
- To link remote sensing with hydrological models for supporting environmental modeling







Time series of near-surface soil moisture based on C-band SAR data for November 2018.

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[1]Romano N., P. Nasta, H. Bogena, P. De Vita, L. Stellato, H. Vereecken. 2018. Monitoring hydrological processes for land and water resources management in a Mediterranean ecosystem: the Alento River catchment observatory. Vadose Zone Journal 17:180042. doi:10.2136/vzj2018.03.0042