

Hyperspectral identification of key monitoring Essential Variables (EVs)

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- ✓ Users require EO-derived Bio-geophysical and morphological indicators to be used as EVs
- ✓ Land cover is already recognized as an essential climate variable (ECV), but it could greatly benefit from multi-sensors synergy.

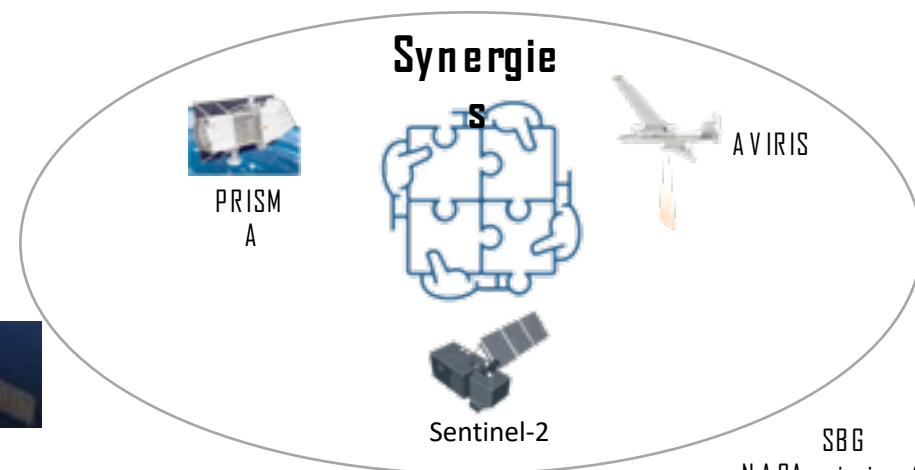


Multi-sensor synergies

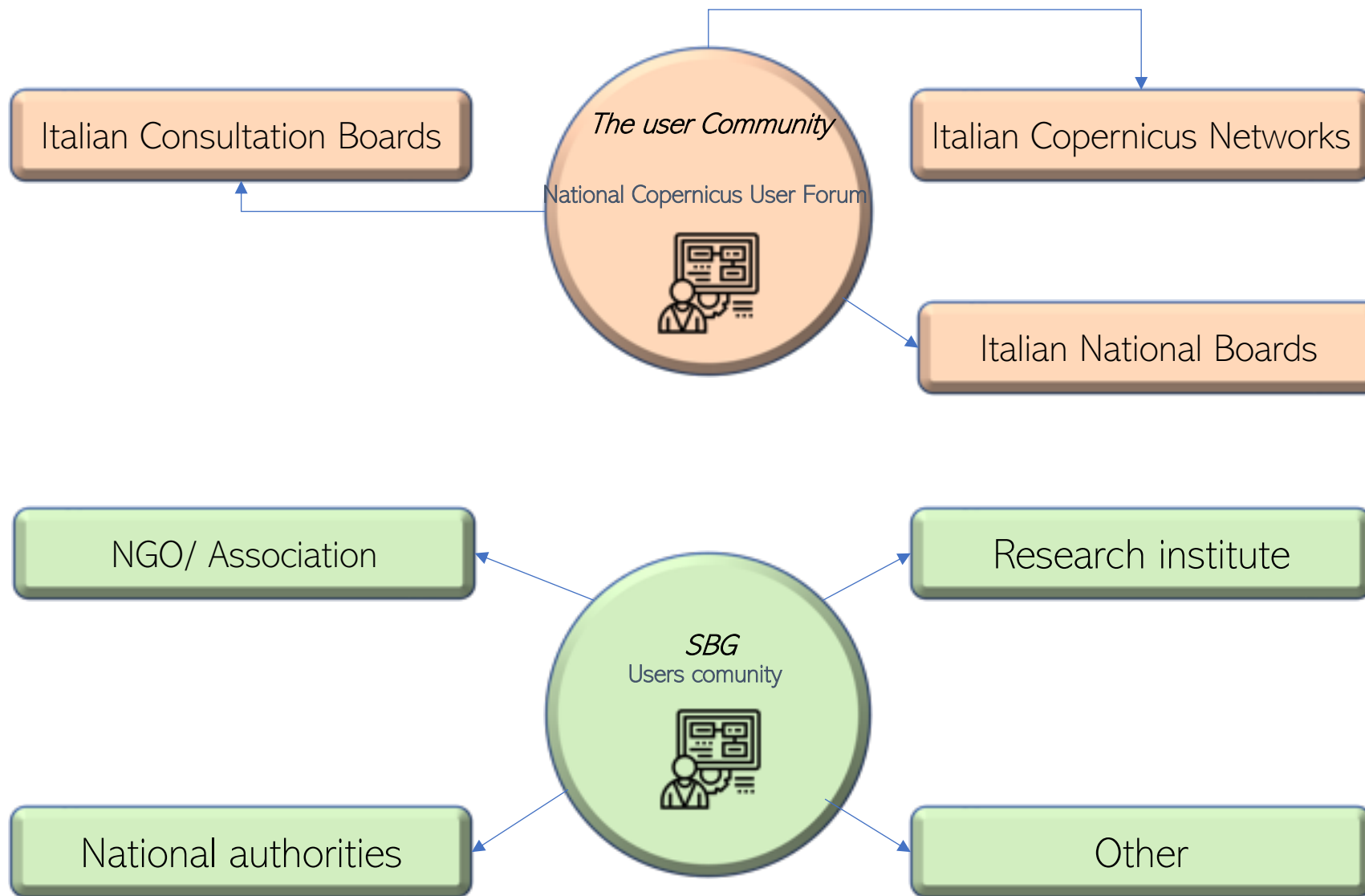
The use of hyperspectral data and the synergy with other types of sensors (e.g. PRISMA, Sentinel-2, AVIRIS), allows to exploit existing algorithms by improving the detection of land cover.



CHIME
EU mission (on going)



SBG
NASA mission (on going)



remote sensing 
Article
An Interaction Methodology to Collect and Assess User-Driven Requirements to Define Potential Opportunities of Future Hyperspectral Imaging Sentinel Mission
Andrea Tarantelli ^{1,2}, Antonella Torrado ^{1,*}, Maria Lucia Magliozzi ¹, Stefano Mariani ³,
Emiliana Valentinis ¹, Massimo Zavagli ¹, Mario Costantini ¹, Jens Nieke ¹, Jennifer Adams ⁴
and Michael Kasi ⁵

sustainability 
Article
Copernicus in Support of Monitoring, Protection, and Management of Cultural and Natural Heritage
Alexandra Boteanu ^{1,2}, Nico Boteanu ^{1,2,3}, Benjamin Enke ¹, Ovidiu Spaschioiu ¹, Antonella Pompea Rechia ⁴
and Andrea Tarantelli ^{1,2,5,6}

water 
Article
User Needs Analysis for the Definition of Operational Coastal Services
Serena Gualdi ^{1,*}, Antonella Biondi ², Giorgio Bellini ³ and Andrea Tarantelli ^{1,2}

Journal of Environmental Management 
Volume 296, 15 October 2021, 113121
Monitoring environmental and climate goals for European agriculture: User perspectives on the optimization of the Copernicus evolution offer
Emma Schiavon ^{1,*}, Andrea Tarantelli ^{1,2,3,4}, Antonella Torrado ^{5,6}, Fabio Pierangeli ^{1,6}



Articles in preparation



Users' interest on the land cover domain is evident across communities of users both geographically and by typology of

users

Italian users community

SBG users community

APPLICATION DOMAIN

Monitoring of land cover and use:

- ✓ *Agriculture / Food Security*
- ✓ *Ecosystem structure/composition (Biodiversity)*

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Parameters/variables to characterize:

- ✓ *Top soil*
- ✓ *Crop composition - structure - health*

Technical requirements required:

- ✓ *HR/VHR*
- ✓ *VIS+NIR+SWIR+ TIR*
- ✓ *From daily to monthly (revisit time)*

Hyperspectral sensors in synergy with other types of sensors

Operative products and services



Article in preparation:

Users' Needs for the Synergetic Use of Planned European and American Hyperspectral Earth Observation Missions: Requirement for Key Service Development and Consolidations
(Autors: IUSS – ISPRA – SBG JPL NASA)



OBJECTIVE: ESSENTIAL CLIMATE VARIABLES RETRIEVAL



Use of **hyperspectral data** and Linear Spectral mixture Analysis (LSMA) to build an image-based **topsoil** retrieval model.



Use of hyperspectral data to recover the Fraction of Absorbed Photosynthetically Active Radiation (**FAPAR**).



The **CHIME project**, evaluates whether the development of a hyperspectral satellite mission offers potential added value to the current Sentinel missions in the application domain application domain.

The study includes:

- ✓ the analysis of user requirements ,
- ✓ the consolidation of retrieval algorithms,
- ✓ the definition of products
- ✓ test of retrieval accuracy analysing hyperspectral images and in situ measurements.



The goal of the OVERSEE project is:

- ✓ to identify both ecological and morphological indicators based on the **multisensor approach**
- ✓ evaluate coastal changes in land cover;
- ✓ map the areas most vulnerable to flooding and erosion processes linked to both natural and anthropogenic pressures.

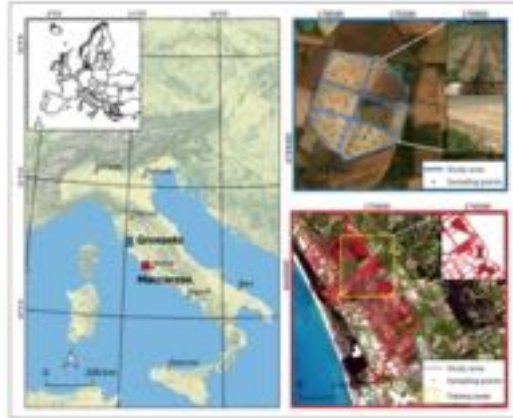


CHEES is the **CHIME end-to-end simulator**.

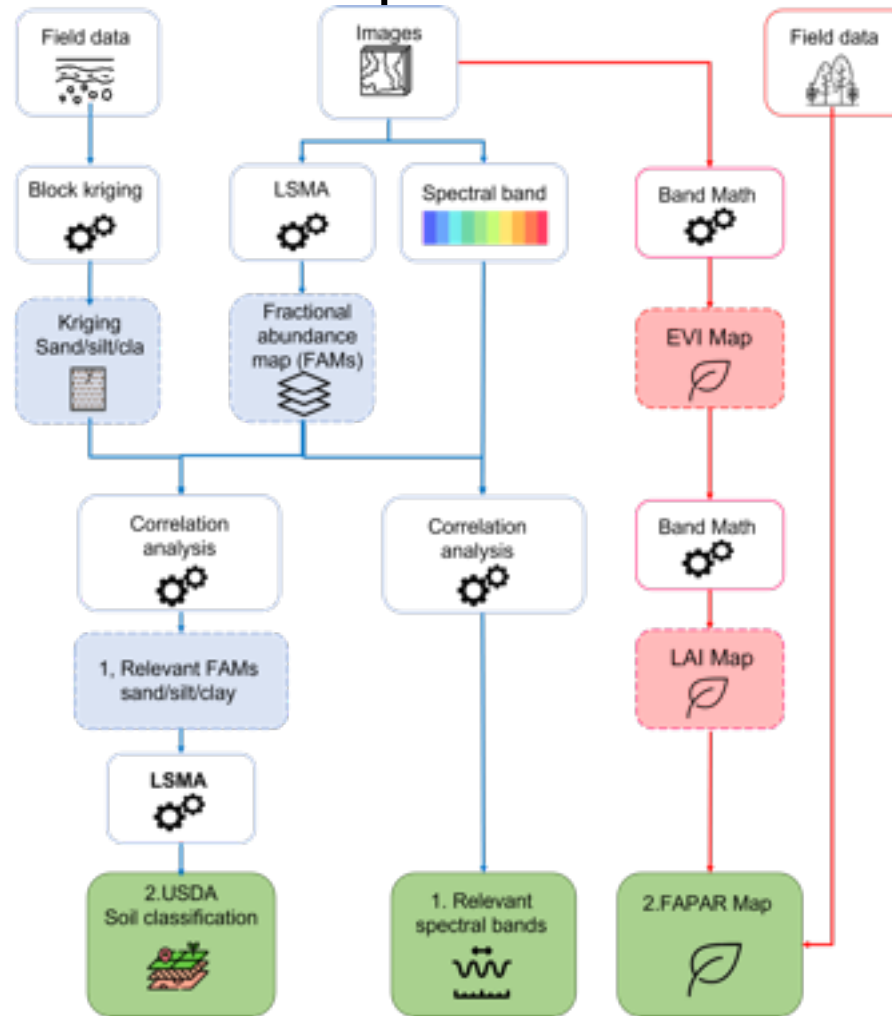
It is a ESA contract that aims at developing the **end-to-end mission performance simulator** - from the observed scene to the retrieved parameters – for the "Copernicus Hyperspectral Imaging Mission for the Environment" - CHIME, which is one of the candidate missions and is currently undergoing industrial Phase



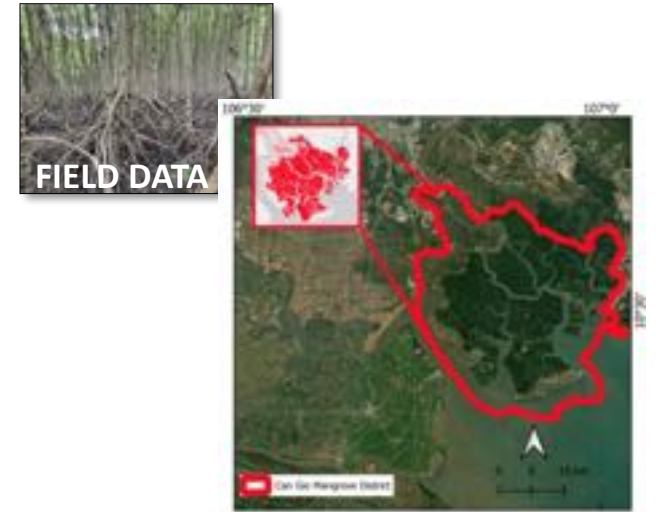
Study area soil fractional cover:
Grosseto, Maccarese (Italy)



FIELD DATA			SATELLITE DATA		
Topsoil texture	Grosseto	Maccarese	Satellite	Spectral bands and spectral ranges (nm)	Spatial resolution
clay			 CHIME	211 bands (400-2500)	20-30 m
silt			 PRISMA	VNIR: 66 bands (400-1010) SWIR: 171 bands (920-2505) Panchromatic: 1 band (400-700)	30 m (VNIR-SWIR) 5 M (Pan)
sand			 Sentinel 2 (A/B)	12 bands (442 - 2202) VNIR = 10 bands (442 - 1373,5) SWIR = 2 bands (1613,7 - 2202,4)	10 m (VNIR) 20 m (RedEdge, SWIR) 60 m (coastal aerosol, water vapour, cirrus)
AIRBORNE DATA					
			 AVIRIS	224 bands (365- 2550)	Spatial resolution depend on flight altitude = 3-17 m



Study area FAPAR:
Can Gio (Vietnam)



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1. Results: Correlation analysis between LSMA, geostatistical products and wavelengths

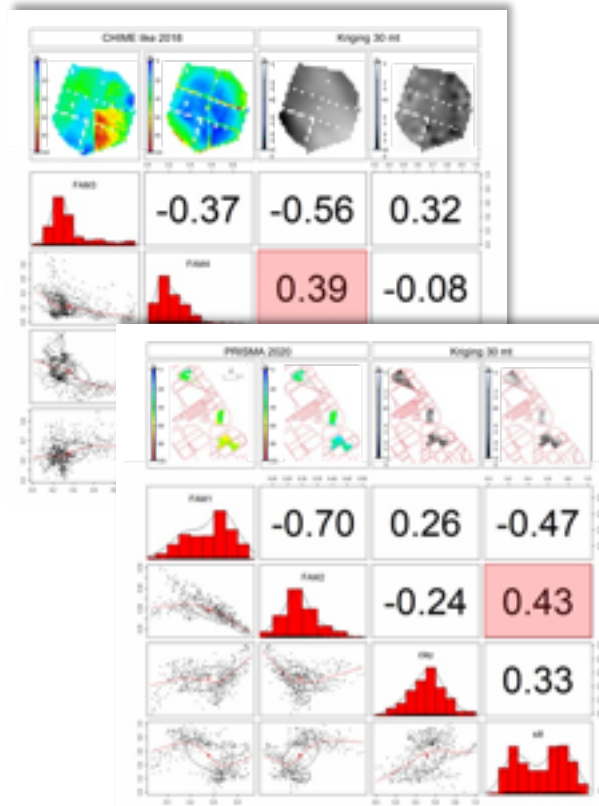
Comparison of topsoil texture retrieval: from image-based LSMA and from geostatistical approaches

GROSSETO

- ✓ The analysis recognized two texture classes, **sand** and **clay**.

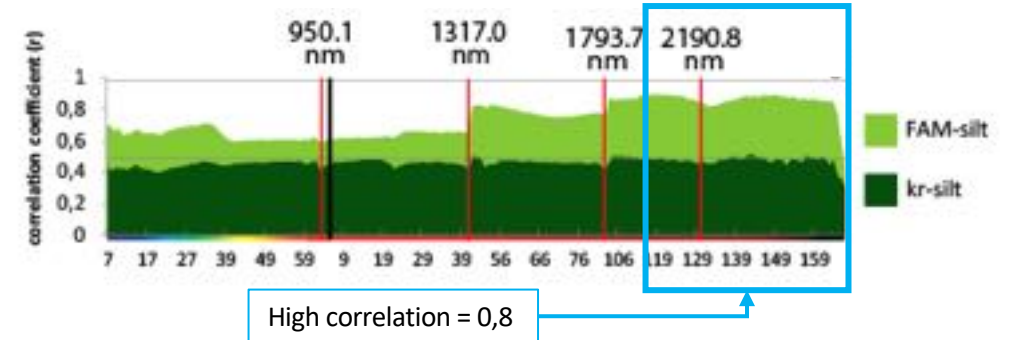
MACCARESE

- ✓ The analysis recognized two texture classes, **clay** and **silt**.

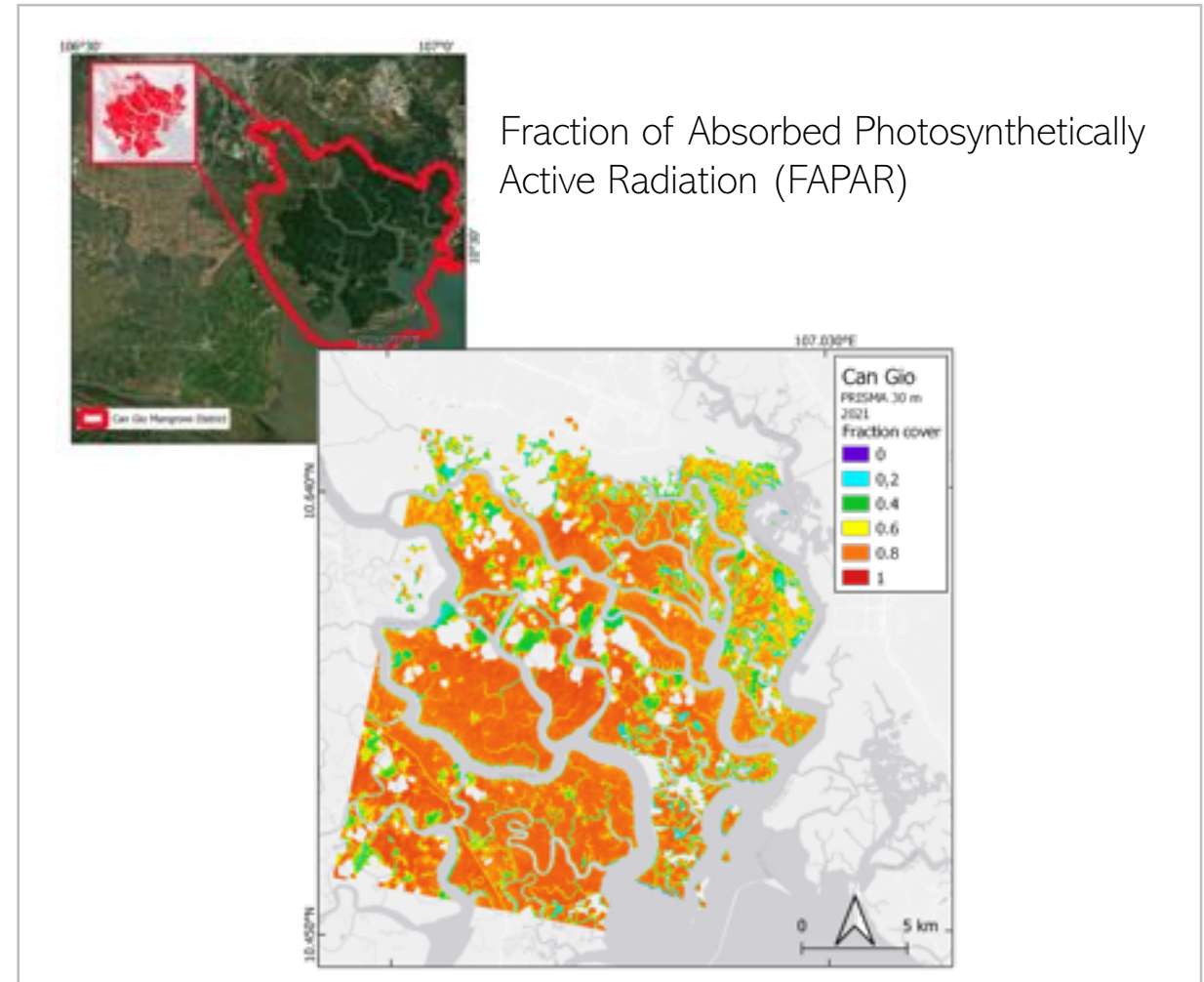
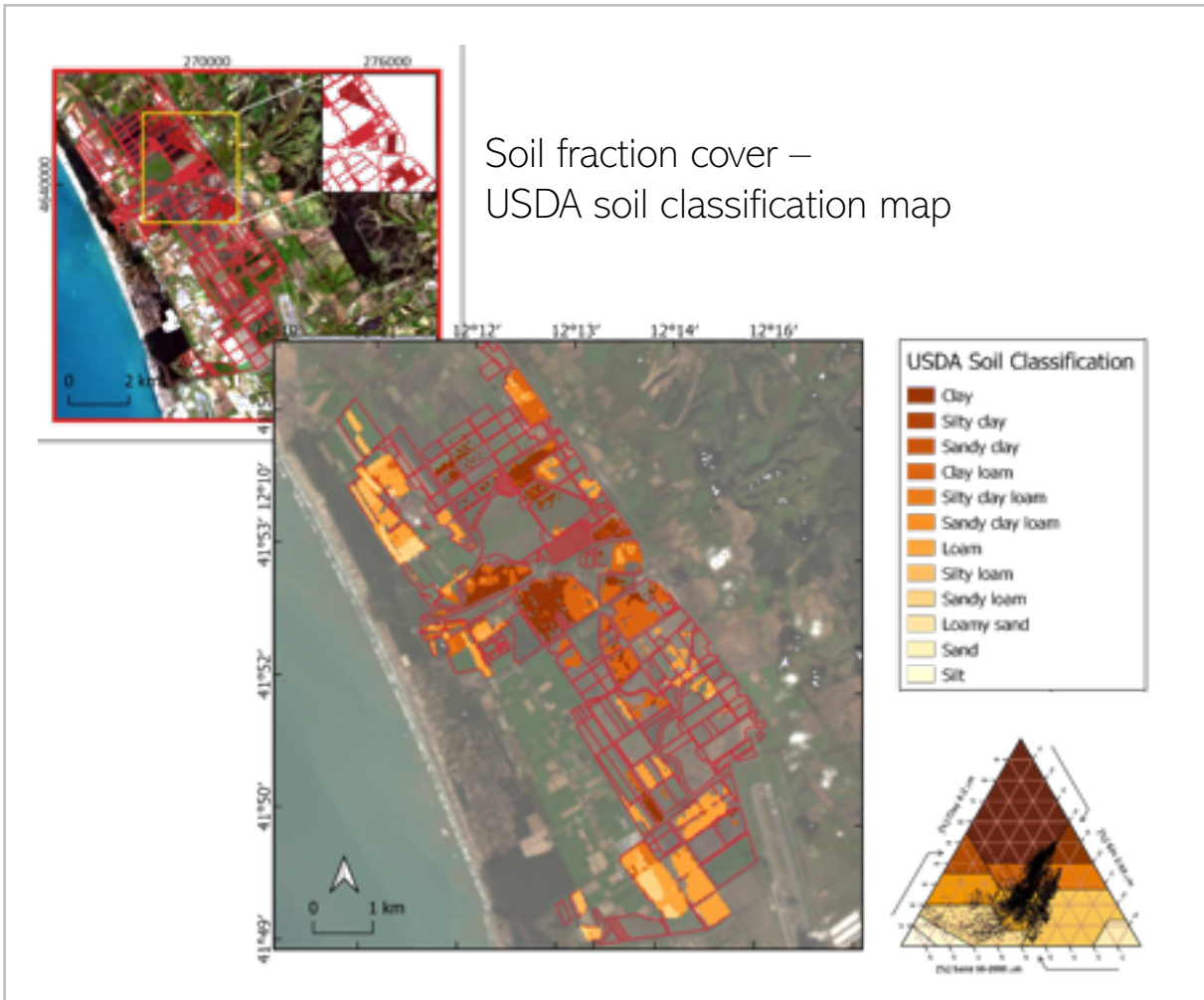


Comparison of FAMs, geostatistical products and wavelengths

- ✓ The correlation cube between the geostatistical products of sand, silt and clay, the relative FAMs and the original wave bands, shows the most significant portion of the spectrum for the recovery of the topsoil texture.
- ✓ The SWIR spectral range 2000-2400 nm is the most relevant part of the spectrum for topsoil retrieval.



Thematic products obtained from the hyperspectral data relating to two EVs: cover and FAPAR





Accuracy:

- ✓ The synergy between sensors has improved surface mapping and retrieval of topsoil texture classes.



Operational products:

- ✓ The adoption of a multi-sensor synergy approach and the implementation of robust methodologies to make monitoring more independent from local calibration and soil truth data.
- ✓ The SWIR has proven its full potential in topsoil texture classes detection, thus paving the way to obtain operational products worldwide.



Operational services

- ✓ The availability of operational products could trigger the development of new operational services based on user operational requirements. An operational products of topsoil texture classes would allow to expand for example the range of services offered by CLMS fulfilling the needs expressed by both the UFN and SBG communities.



Cooperation in spaceborne imaging spectroscopy:

- ✓ The development of a virtual constellation characterized by several sensors and with a higher temporal resolution, will allow the generation of more accurate land cover products independently from site specific conditions.
- ✓ The new Italian satellite constellation IRIDE currently under development, beside supporting national policies, planning and activities management could certainly contribute to cooperation in spaceborne imaging spectroscopy.

Thanks for your attention!