Il sito Apulian Tavoliere per applicazioni in agricoltura e attività cal/val di OT

Outline

- Motivations for long-term EO test sites
- Apulian Tavoliere characteristics & Infrastructure
- Hydrology & Agriculture Research activities
- In situ & Observational activities as a possible support to PRISMA

F. Mattia, G. Satalino, A. Balenzano, F. Lovergine, A. Daddabbo, A. Milella, G. Attolico

V. Iacobellis, A. Gioia, S. Siad, F. Sciacqua

M.Rinaldi, A. Castrignanò, S. Ruggieri, G. Rana, C. Riefolo, G. Annichiarico

P. Toscano, B. Gioli, A. Matese, F. Di Gennaro, A. Zaldei

The context

- **Guidelines: GEOSS/GEO/QA4EO**

  - "all Earth observing (EO) data and derived products should have associated with them a quality indicator based on a documented **quantitative assessment** of its traceability to internationally-agreed-upon **reference standards** (e.g. SI units)"

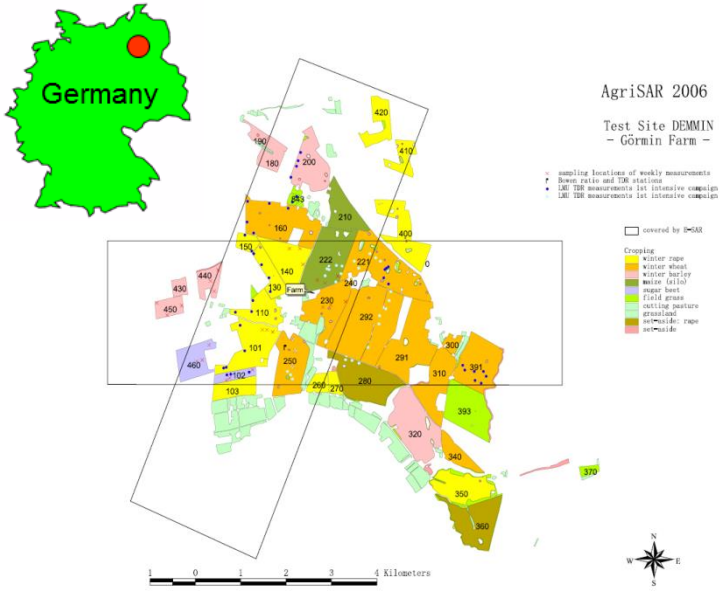
- **Validation of measurements and products**

Two data approaches/sources exist (Bojkov, June 2012):

- Use of routine network data (e.g. meteorological measurements) achieving the statistics by numbers;
- Specialized (targeted) activities (e.g. land targets, balloons/aircraft, specialized assets, instrument intercomparisons) – understanding of processes or measurement technique differences

- **Development (maintenance) of validation infrastructures is crucial to the Cal/Val activities**

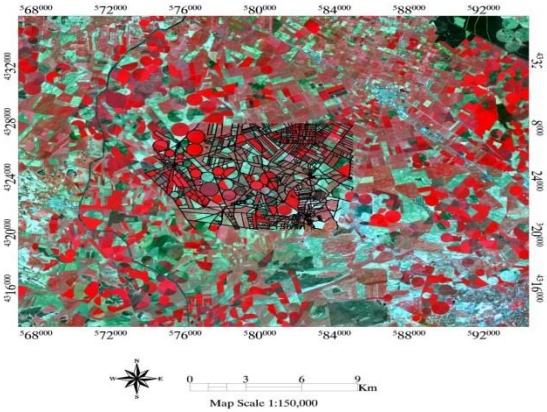
Int. examples of specialized land targets



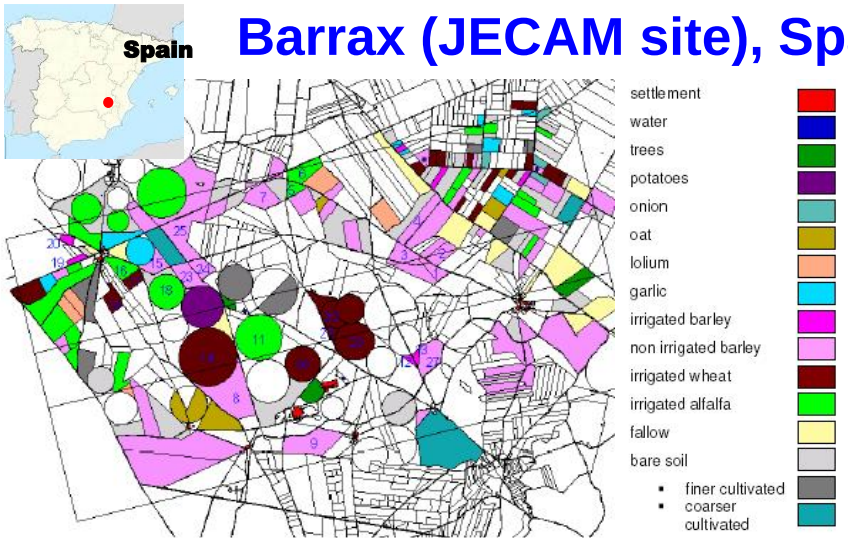
Durable Environmental Multidisciplinary Monitoring Information Network (DEMIN)

Borg, E., Lippert, K., Zabel, E., Löpmeier, F.J., Fichtelmann, B., Jahncke, D., Maass, H. (2009): DEMMIN – Teststandort zur Kalibrierung und Validierung von Fernerkundungsmissionen.- In: 15 Jahre Studiengang Vermessungswesen – Geodätisches Fachforum und Festakt, Neubrandenburg, Eigenverlag (Hrsg.: Rebenstorf, R.W.).- 16.-17.01.2009.- S. 401-419.

Two multi-mission cal/val EO sites: land-agriculture

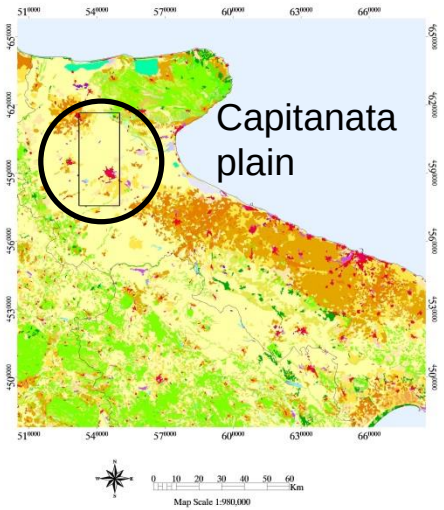


Barrax (JECAM site), Spain

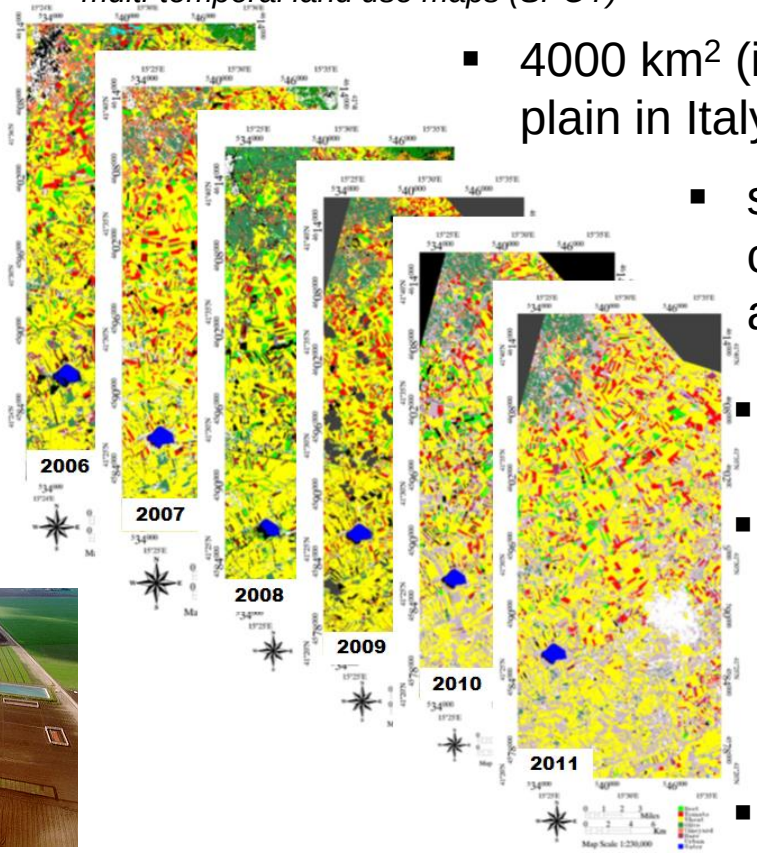


What is the Apulian Tavoliere?

- *Agricultural areas (CORINE)*



multi-temporal land use maps (SPOT)



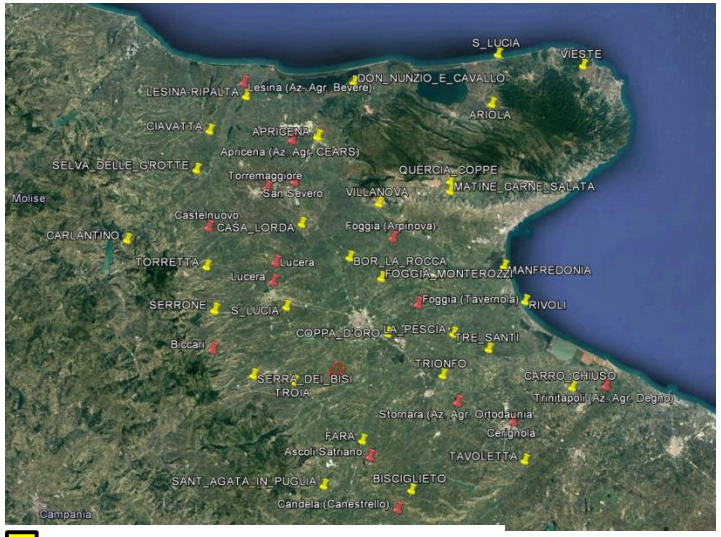
Presence of CREA experimental farms managing more that 600 ha & CNR institutes & Universities & Research Centers

- 4000 km^2 (i.e. the second largest plain in Italy)
  - semi-arid Mediterranean climate (annual rainfall about 550 mm)
  - almost flat topography
  - crops: durum wheat, barley, oat, tomato, fava bean, checkpea, artichoke...
  - JECAM site (http://www.jecam.org/)

- highly anthropogenic environment & increasing evaporative demand → significant reduction in water availability & increased water demand (e.g. irrigation, energy, industry, etc.) → **risk of future yield loss**

Infrastructure

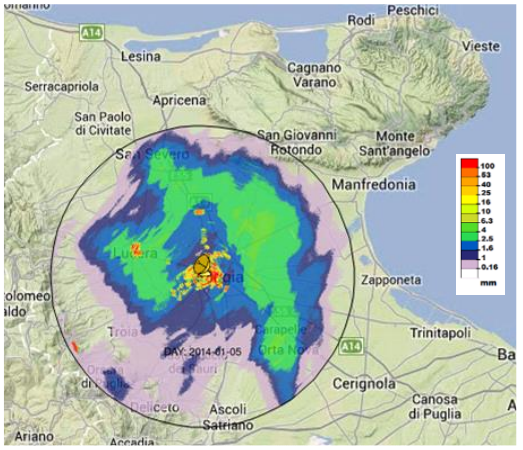
Network of 47 Agrometeorological Stations over the Apulian Tavoliere



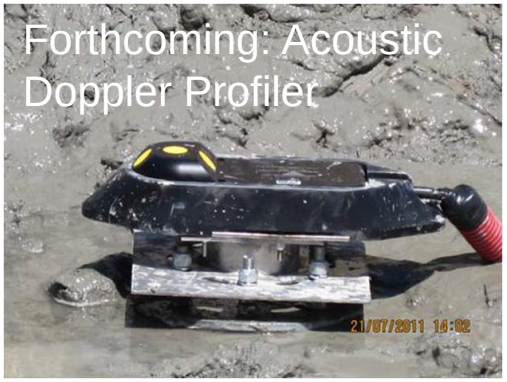
Servizio Agrometeorologico Regionale (31)

Stazioni Consorzio di Bonifica (16)

High resolution X-band meteo radar

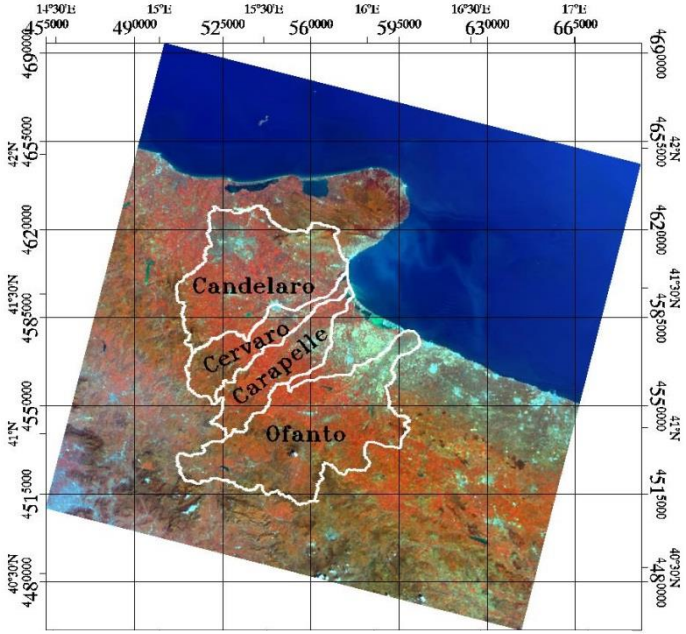


Hydrologic network (12 soil moisture stations)

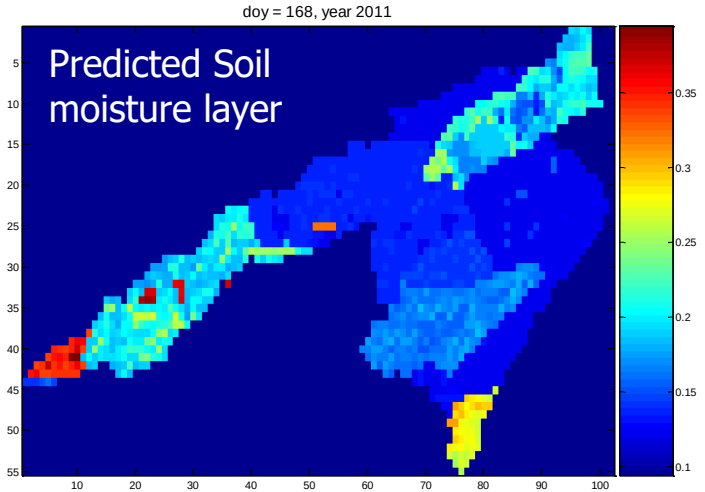


evaluate basin discharge at the outlet

Hydrology



- modeling runoff and soil moisture space-time distribution at the catchment scale
- validation and development of models for the estimation of the soil moisture in the root zone (SMAR, Manfreda et al 2014).



Iacobellis et al., EJRS, 2013

Main topics related to hyperspectral data

- ✓ Land use
- ✓ Vegetation indexes & crop covering e growth development
- ✓ Tilled / no-tilled soil change
- ✓ Plant water status &Transpiration/Evaporation ratio & Crop water stress
- ✓ Plant health status
- ✓ Irrigated and No-Irrigated fields
- ✓ Crop water requirement & irrigation scheduling

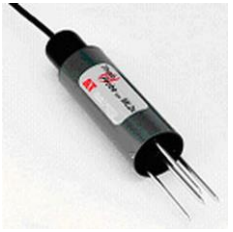
Observations:

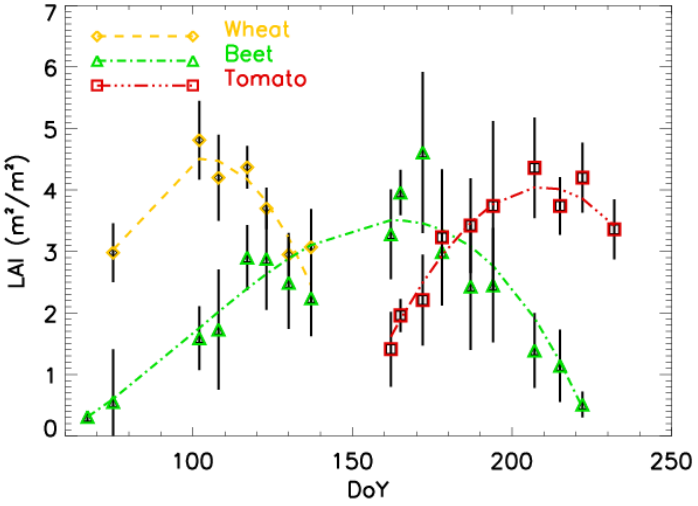
- ✓ in situ measurements
- ✓ laboratory & proximal & aerial & remote sensing

In situ measurements

- Crop type & planted area & crop phenology
- Soil Moisture, latent & sensible heat and carbon dioxide fluxes
- LAI, FAPAR, Cover fraction
- Plant Biomass & Plant Water Content

Leaf Area Index



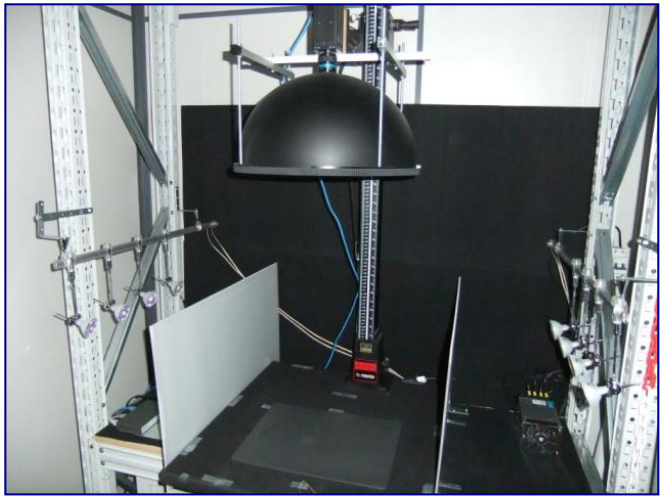


Soil moisture sampling

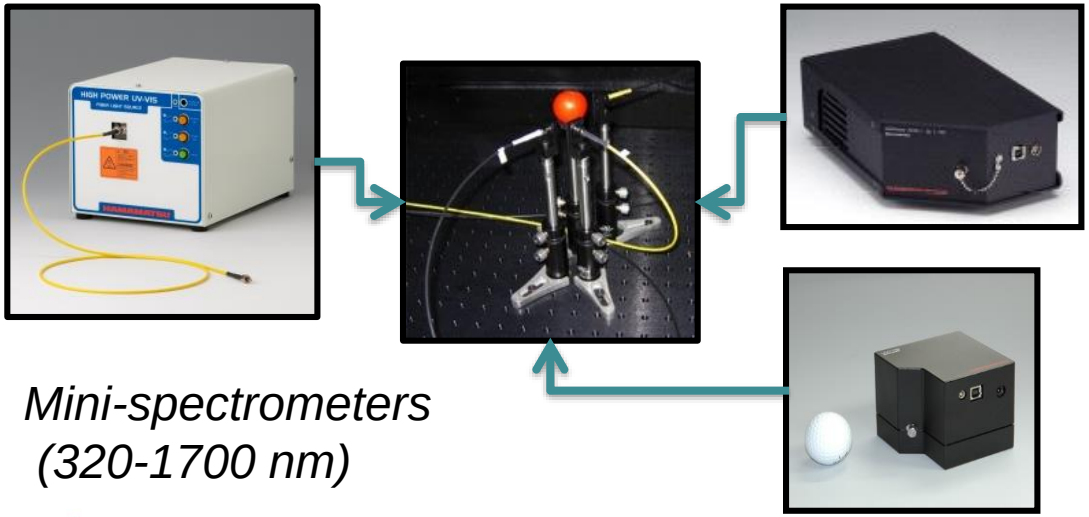
Fluxes

H2020 SENSAGRI (www.sensagri.eu)
FP7 IMAGES global network (http://fp7-imagines.eu/)
MIPAAF AQUATER (http://www.inea.it/aquater)
ESA Exploit-S-1 (www.exploit-s-1.ba.issia.cnr.it)
ASI COSMOLAND (http://www.issia.cnr.it/wp/)

Laboratory for multispectral image analysis

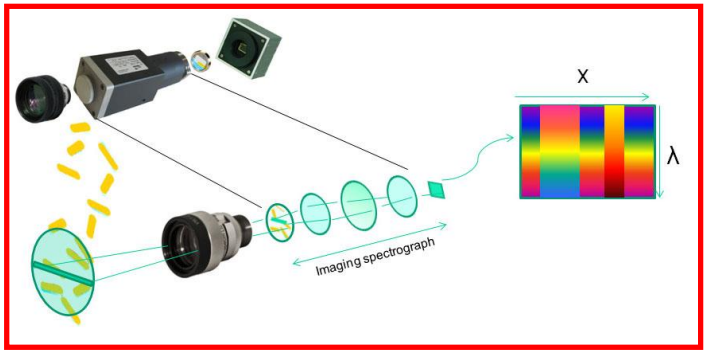


- ***Non destructive evaluation*** of ***quality*** and ***internal parameters***: antioxidant activity, phenols, ammonium, chlorophyll content, …)



Mini-spectrometers (320-1700 nm)

Linescan Spectrograph (400-1000 nm)



MULTISPECTRAL IMAGE ANALYSIS(ISSIA)

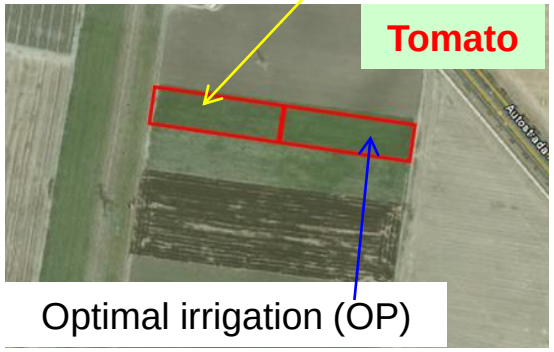
Pace et al., Postharvest Biology and Technology, 2011; Pace et al., Journal of Food Engineering, 2013; Pace et al., Food Research International, 2014; Pace et al., Innovative Food Science and Emerging Technologies, 2015

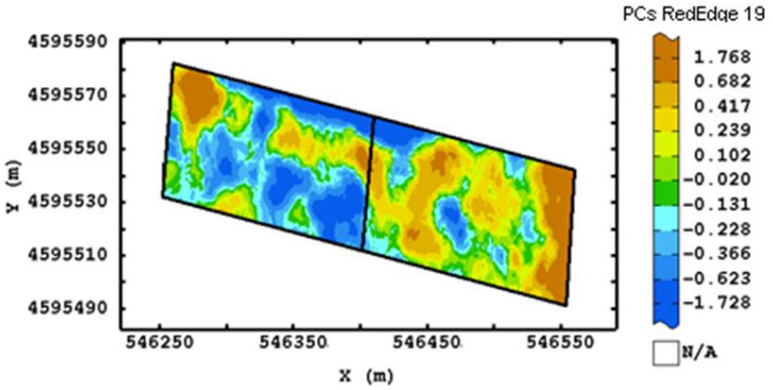
Hyperspectral proximal sensing

Field Spec: 325-1075 nm

Recording date	Electromagnetic spectrum band interval
9 August	Coastal-blue
	Green
	Yellow
	Red
	Red-edge
	Near infrared (NIR)
13 August	Coastal-blue
	Green
	Yellow
	Red
	Red-edge
	NIR
19 August	Coastal-blue
	Green
	Yellow
	Red
	Red-edge
	NIR

✓ Plant water & health status





Rinaldi et al., Environmetrics 2015

- "The bands that are more suited to discriminate the plants with different water status are the green (510-580nm) and the red-edge (705-770nm), because of their greater sensitivity to the plant health, and thus the water content"

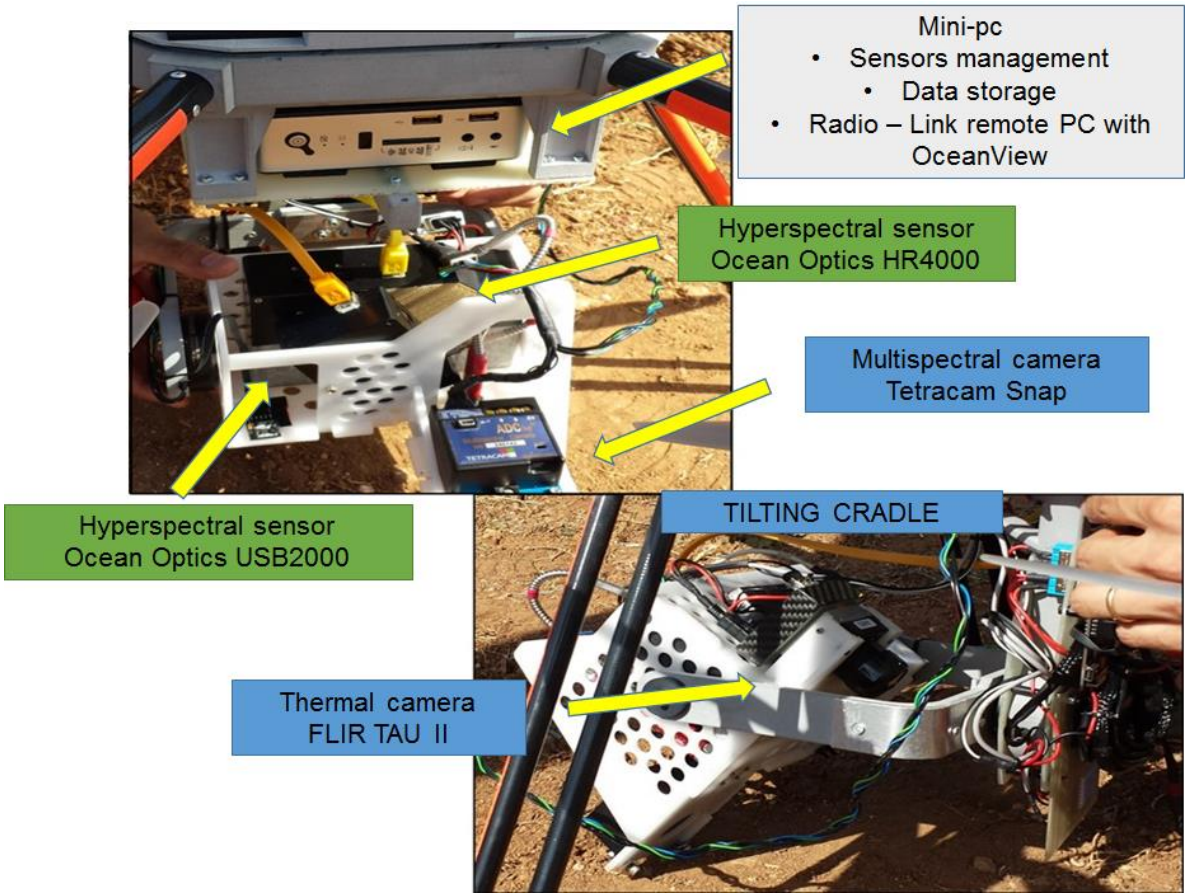
Aerial hyperspectral sensing

- UAV Mikrokopter electronic (12 engines; maximum take off weight: 12 kg; maximum endurance: 17 min; Flight altitude: 0 - 150m; Fligt distance: <500 m radius)

Payload:

- multispectral camera (Tetracam Snap)
- thermal camera (FLIR TAU 2)
- two spectroradiometers (USB2000 & HR4000)
- a mini PC

Total weight of = 5 kg



Sensor characteristics

✓ quantify water stress indices & photosynthetic activity

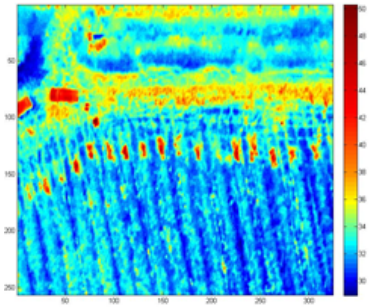
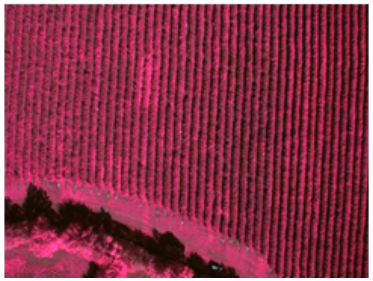
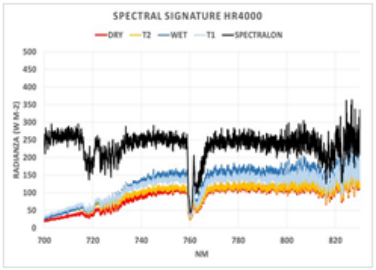


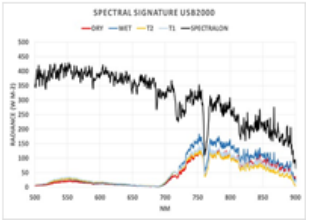

	FLIR TAU 2	TETRACAM ADC SNAP	OO - HR4000	OO - USB2000
Spectral wavebands	7500-13500 nm	520 - 600 nm RED 630 - 690 nm GREEN 760 - 900 nm NIR	650-850 nm	340 - 1000 nm
Dimension	44.5 x 44.5 x 30 mm	114 x 77 x 22 mm	148.6 x 104.8 x 45.1 mm	89 x 64 x 34 mm
Weight	70 g	90 g	570 g	200 g
Resolution	324 x 256 pixel	1280 x 1024 pixel	0.2 nm (FWHM)	1 nm (FWHM)
Ground resolution x Flight altitude	13 cm -> 100 m AGL	4 cm -> 100 m AGL	10 m -> 4.5 m diametro a terra	10 m -> 4.5 m diametro a terra
FOV	24° x 18°	42.5° x 32.5°	25°	25°

$$\text{CWSI} = \frac{T_{dry} - Tleaf}{T_{dry} - Twet} \qquad \text{NDVI} = \frac{NIR - RED}{NIR + RED}$$

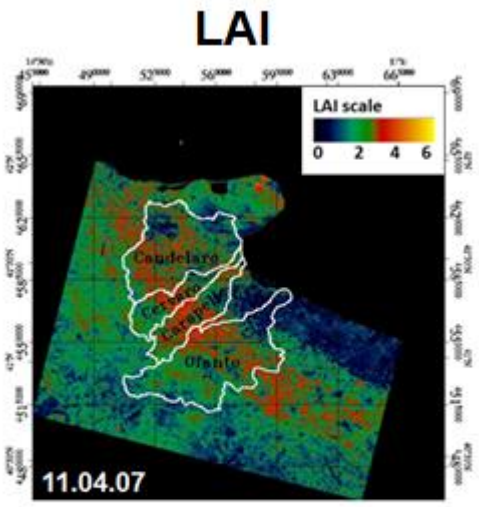
$$SIF\ O_2\ A = 760{,}2 \qquad SIF\ O_2\ B = 687$$

$$\text{PRI} = \frac{570 - 531}{570 + 531}$$



EO multitemporal & muti/hyperspectral data



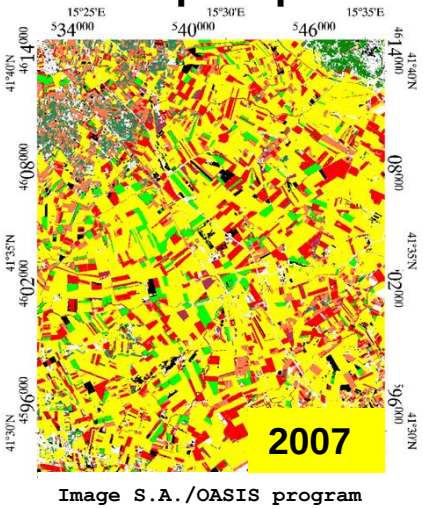
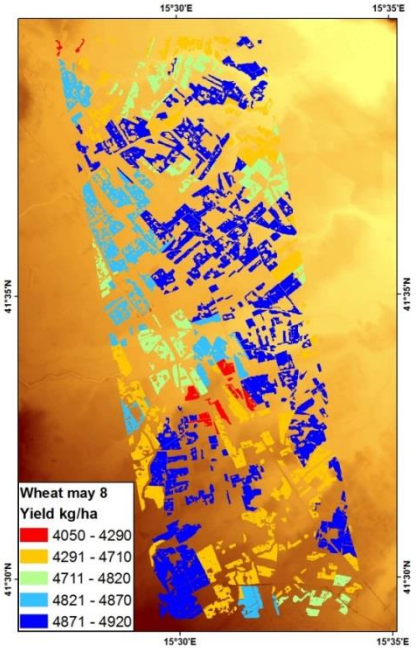


Image S.A./OASIS program

- EO & crop growth models to improve crop management & yield predictions & reduce environmental impact

Wheat yield map

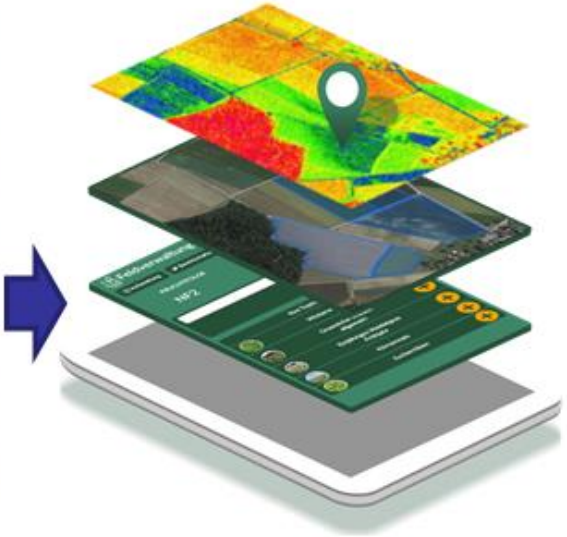


Crop growth models assimilating EO data to improve yield predictions

- today generally empirical (time/site dependent) relations transform EO data into vegetation indexes (e.g. LAI) & crop parameters
- multitemporal & hyperspectral EO data to enable physical / physiological based retrieval (more general & robust & accurate)

Collaborative Agricultural Vehicles (S3-CAV)

FP7 ERA-NET ICT-AGRI-2



- *Multi-sensor obstacle detection*
- *Multi-modal 3D maps*
- *Situation awareness*
- *Crop assessment and recognition of condition*
- *Trafficability*
- *Traversability*

http://s3cav.eu/

Partners

- Danish Technological Institute (Denmark)
- University of Salento (Italy)
- Fraunhofer Institute for Intelligent Analysis and Information Systems IAIS (Germany)
- CNR - Institute of Intelligent Systems for Automation (Italy)
- AgriCircle AG (Switzerland)

Summary

- The Apulian Tavoliere is an agricultural site that can largely benefit from the use of PRISMA data for improving crop management & irrigation scheduling & yield prediction

- Over the site there exist facilities and know how to support calibration & validation of OT products for agricultural applications

- Requirements in terms of thematic applications, geographic location, readiness level of technological & scientific infrastructure should be elaborated at national level and then **strategic decisions should be taken**

Thanks for your attention