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SENTINEL-2 AND UAV MULTISPECTRAL IMAGERY FOR SITE-SPECIFIC CROP AND WEEDS DETECTION

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Dragon 4 ID#32775 Topic 1

Outlines

- Introduction
- Test area crop and weeds
- spectral weed identification and spectral characterization
- UAV campaign
- Hyperspectral processing
- RapidEye & Sentinel2 processing
- Conclusion

Introduction

Maps of crop and weeds at the field-scale could be of great interest with major economic and environmental impacts.

Weed classification is an essential requirement for site-specific weed management in the context of precision agriculture, allowing a considerable reduction of herbicide spraying, with favorable environmental consequences.

The extraction of features (spatial and/or spectral) that discriminate between the weeds of interest and background objects (i.e. different soils and crops) is crucial to map and monitor weeds in agricultural fields.

The development of new generation multispectral satellite sensors and hyperspectral UAVs sensors has resulted in significant interest in their use for crop and weeds classification applications in view of their high spatial/spectral resolution.

Test area

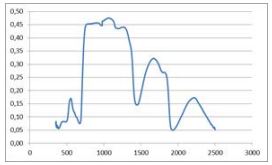
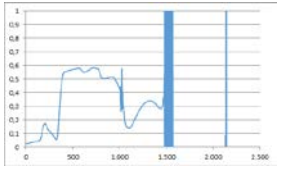
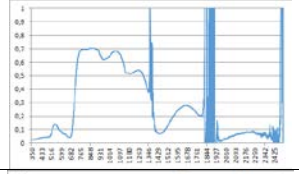
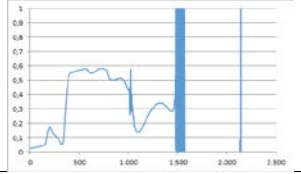
The test area (2.1 ha) is located in Central Italy North to Rome.

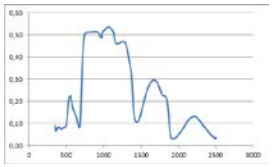
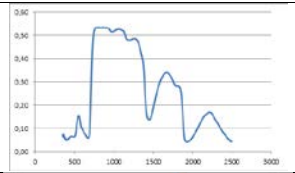
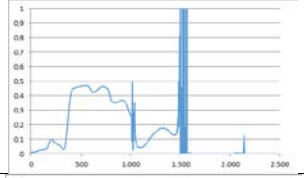
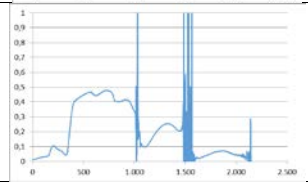
The study area is covered by crops, including wheat, maize fava beans. During the year wheat, crop and maize have been analysed

Most fields were located on flat soil with relatively uniform soil properties and cultural practices and are therefore relatively homogeneous.

Weeds characterization

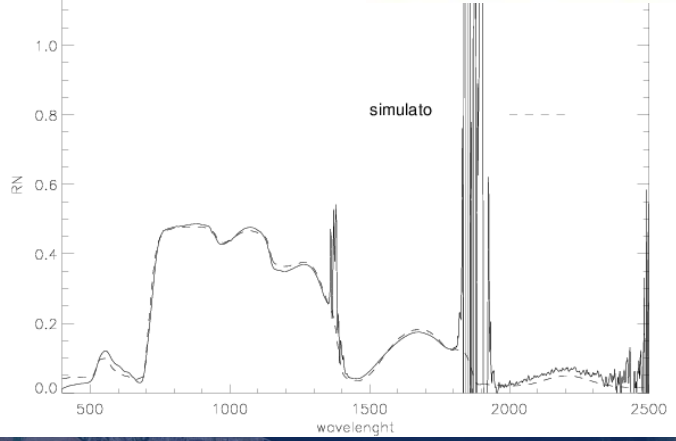
More then 15 weeds on 3 different crops have been spectrally characterized

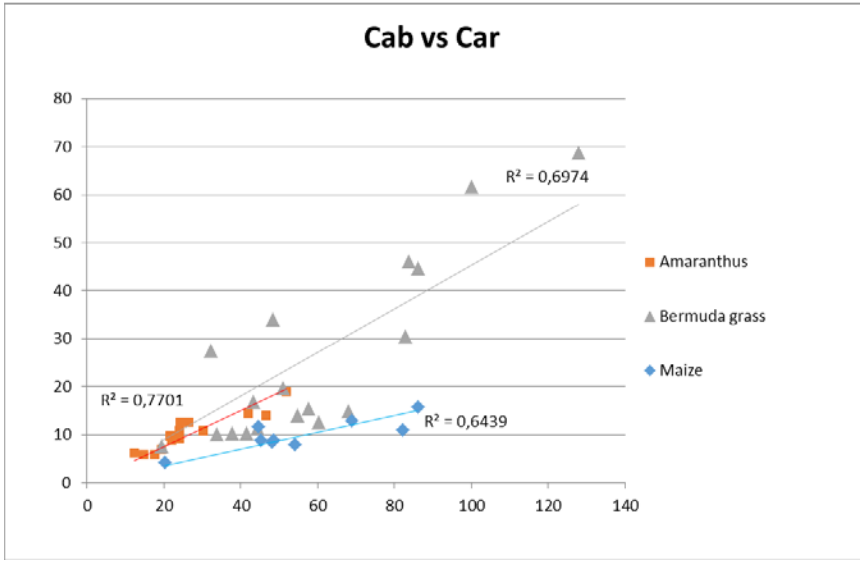
Winter Wheat		
Artemisia vulgaris L. *common wormwood*		
Chenopodium Album L. *lambsquarters*		
Amaranthus retroflexus L.		

Veronica filiformis *threadstalk speedwell*		
Convolvulus arvensis *field bindweed*		
Sorghum halepense **L.** *Johnsongrass*		
Cynodon dactylon (L.) Pers. *Bermudagrass*		

Weeds characterization

Amaranthus retroflexus L.





Remote data

Radip Eye –on 2016/06/15

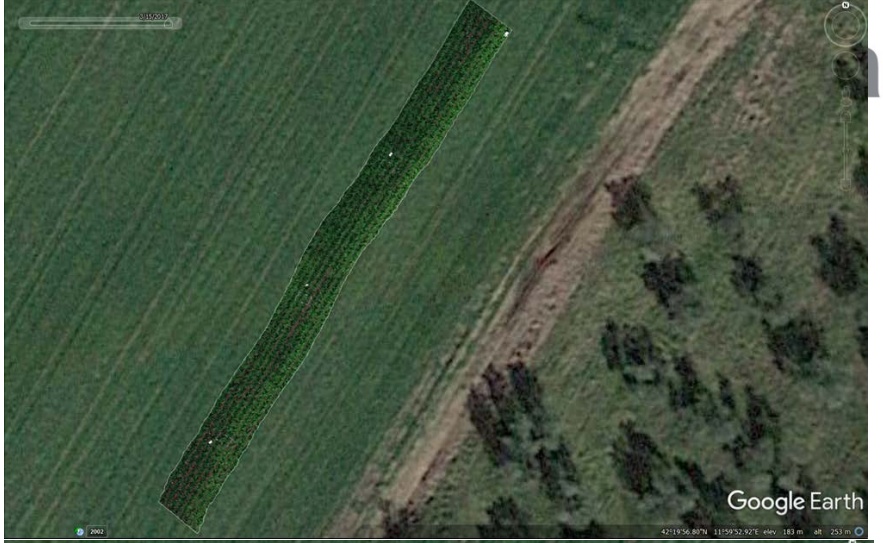
Hyperspec III – on 2016/06/14 with cm resolution with Nano hyperspectral ; UAV octocopter

Sentinel-2 - on 2016/07/18

	Hyperspec	RapidEye	S-2
	16/06/2016	14/06/2015	18/07/2016
Wavelength range	400-1000nm	475-805nm	490-2190nm
Spatial Bands	640		
Spectral Bands	270	5	10
Spectral res.	2-3nm	70-90nm	98-245

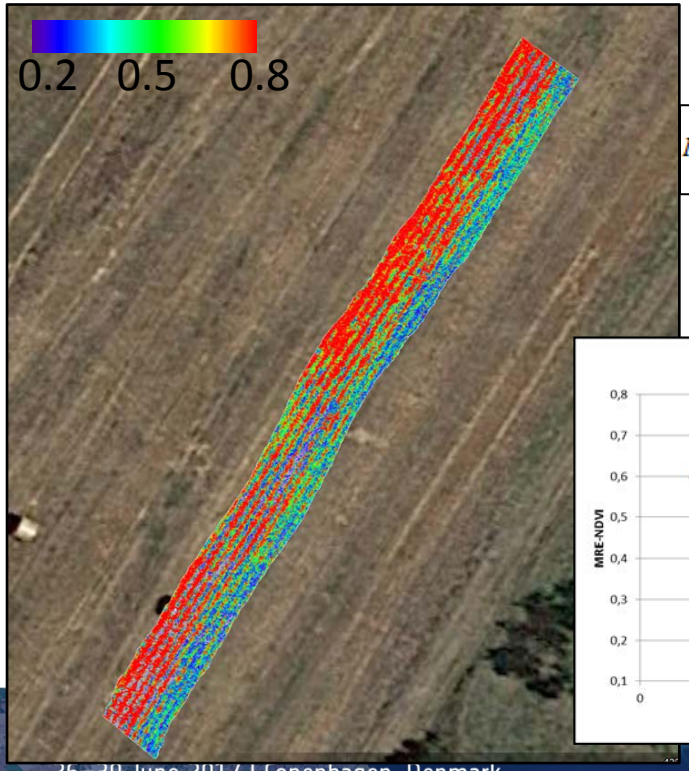
Drone

Hyperspec III – Nano hyperspectral imagery acquired with a octocopter on 14/06/2016 overlaid on Google Earth

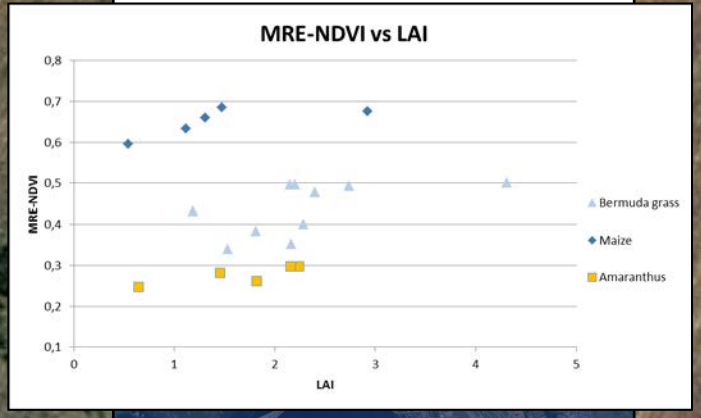


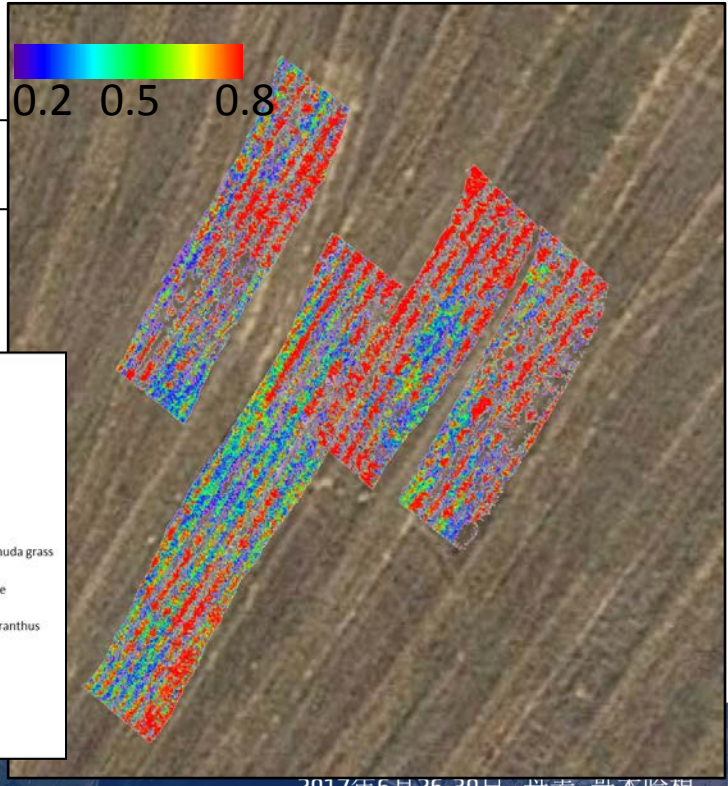
Modified Red Edge Normalized Difference Vegetation Index (MRE-NDVI)

is a modification of the Red Edge NDVI that corrects for leaf specular reflection. It capitalizes on the sensitivity of the vegetation red edge to small changes in canopy foliage content, gap fraction, and senescence. The index ranges from -1 to 1. The common range for green vegetation is 0.2 to 0.7. (Datt, 1999; Sims and Gamon, 2002)

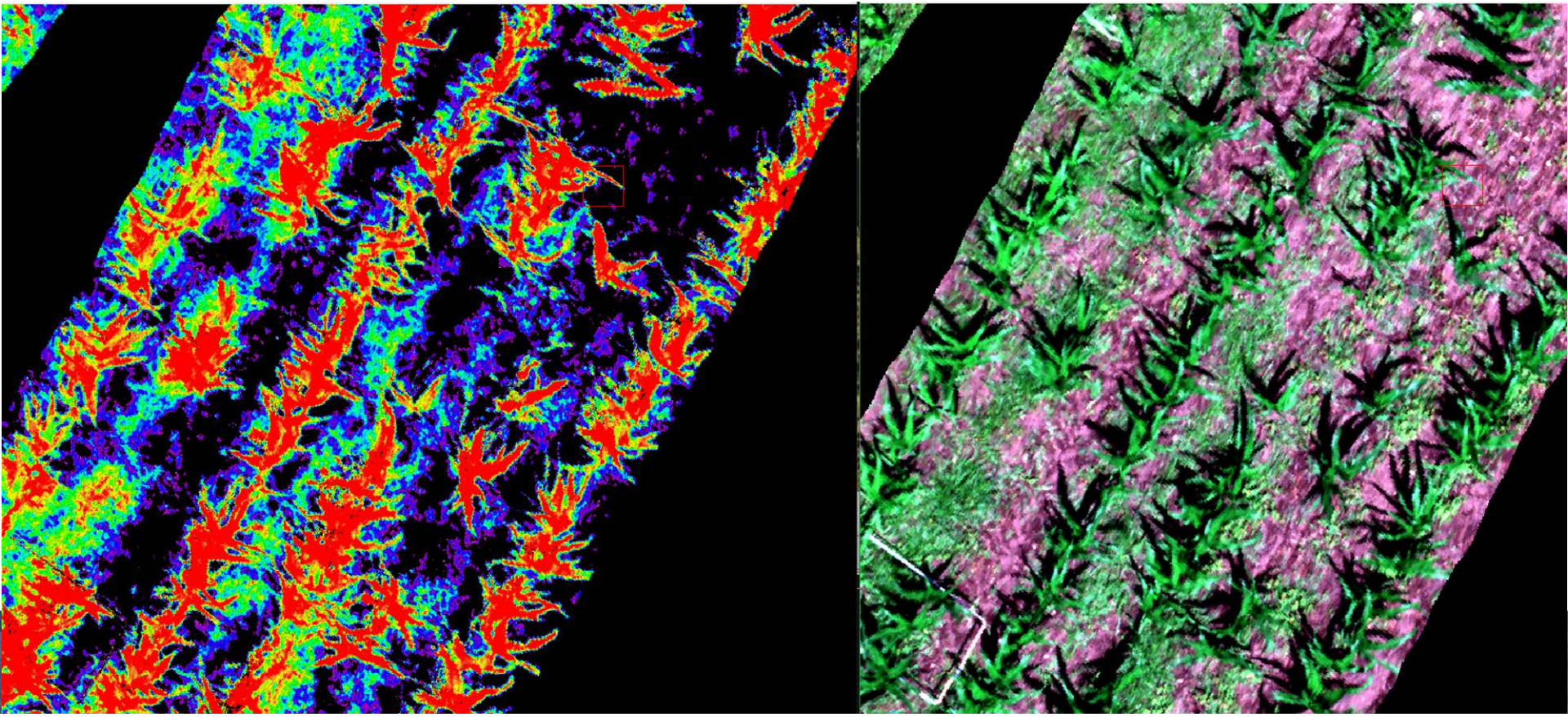


$$MRENDVI = \frac{\rho_{750} - \rho_{705}}{\rho_{750} + \rho_{705} - 2 * \rho_{445}}$$

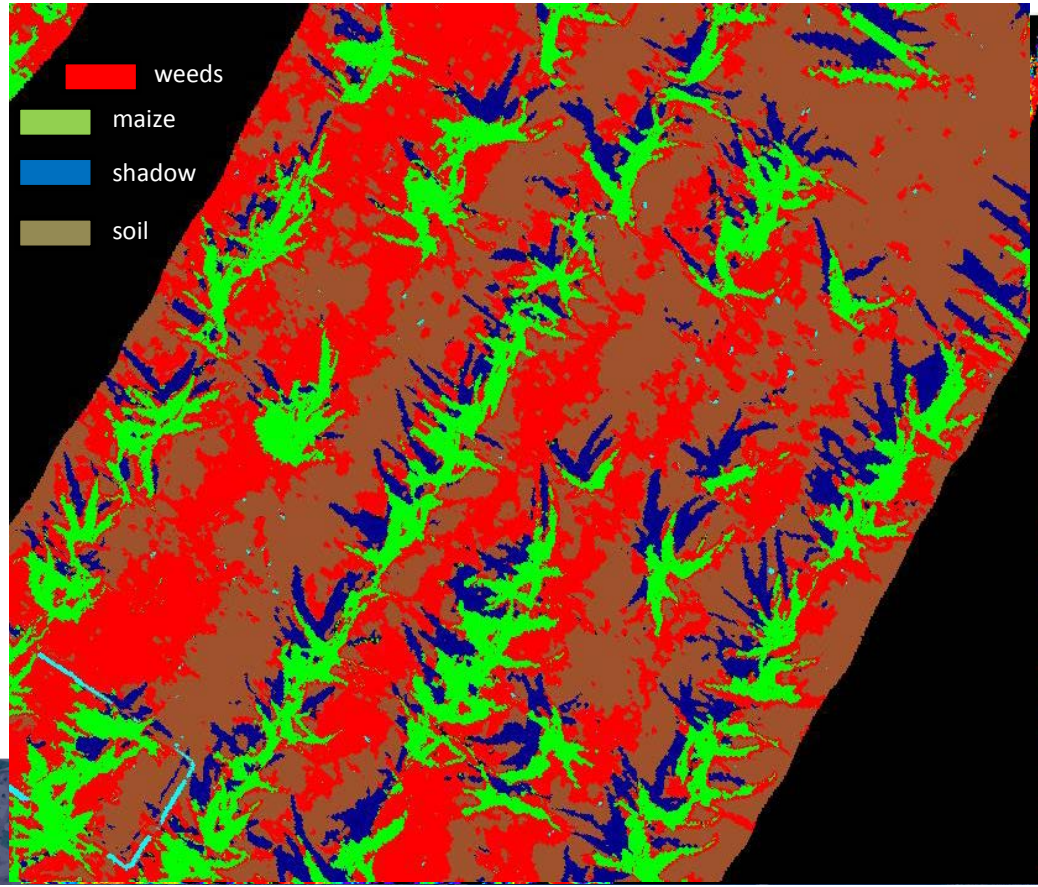


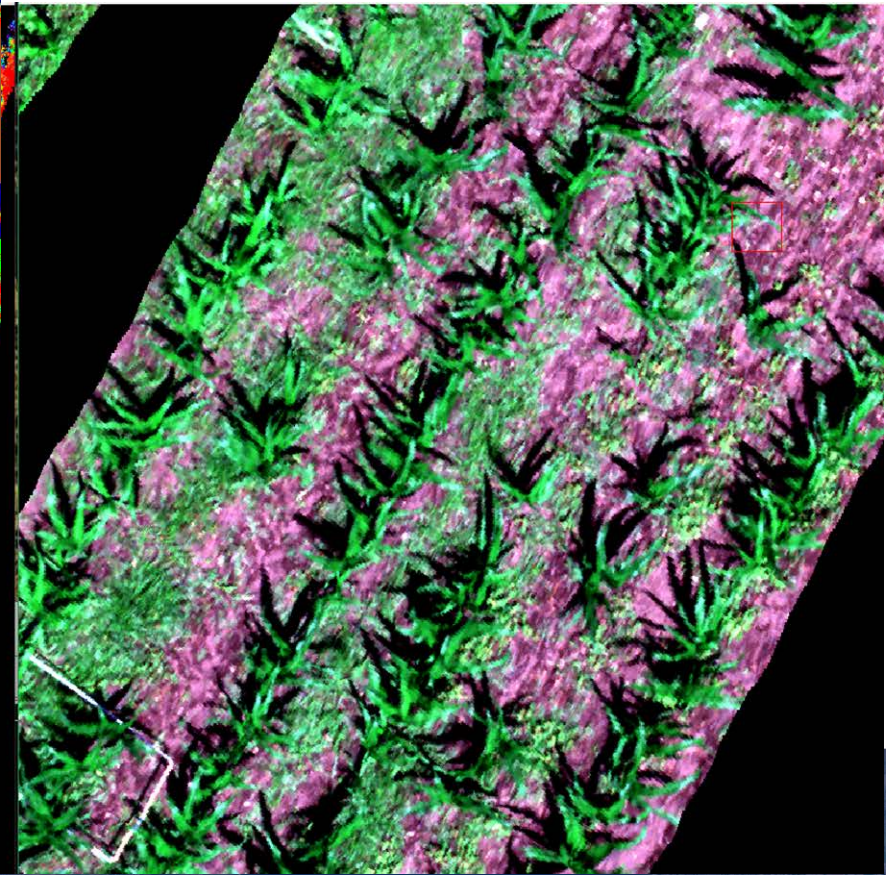


Modified Red Edge Normalized Difference Vegetation Index (MRE-NDVI)



SVM classification





Class Distribution Summary

Soil: 2,973,712 points (26.58%) (190.5667 Meters²)

Maize: 4,232,819 points (37.84%) (271.2550 Meters²)

Weeds: 2,821,649 points (25.23%) (180.8219 Meters²)

Shadow: 1,098,011 points (9.82%) (70.3647 Meters²)

Plastic ruler: 59,727 points (0.53%) (3.8275 Meters²)

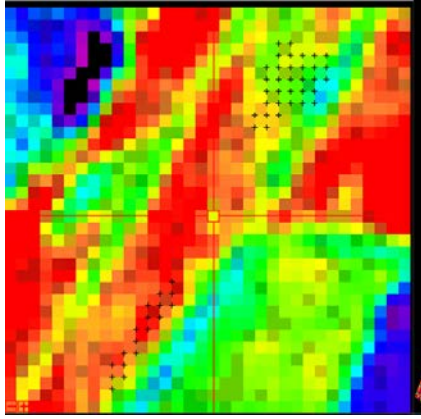
Total Vegetation: 63%

RGB RapidEye

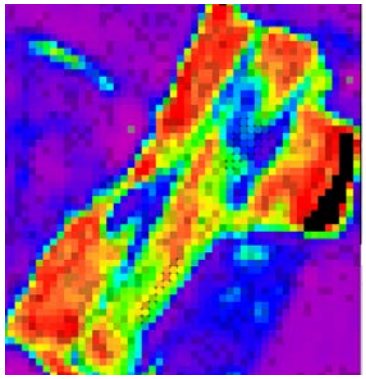
MRE-NDVI
Drone

low

NDVI RapidEye

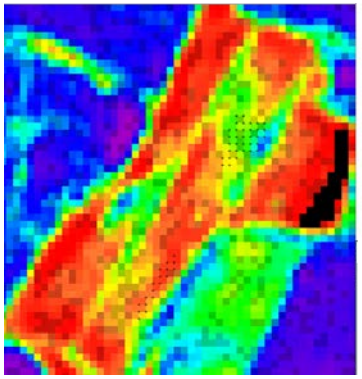


Rapid-Eye biophysical maps (BV-NET biophysical processor tool box)



0 5

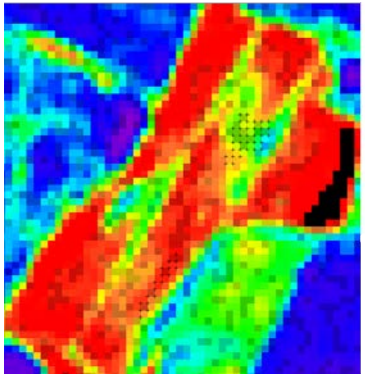
LAI (Leaf Area Index)



0 1

FCOVER

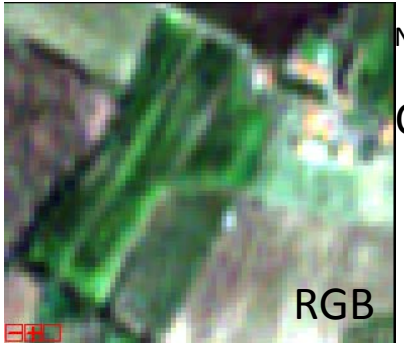
(Fraction of green vegetation Cover)



0 1

FAPAR

(Fraction of Absorbed Photosynthetically Active Radiation)



Non retrived by BV-NET on this specific image

Cab (Chlorophyll content in the leaf)

Cab mean: 59,20

Cab devSt: 16,25

Class Distribution Summary

svm	drone
Soil	26.58%
maize	37.84%
weeds	25.23
Total veg.	63%

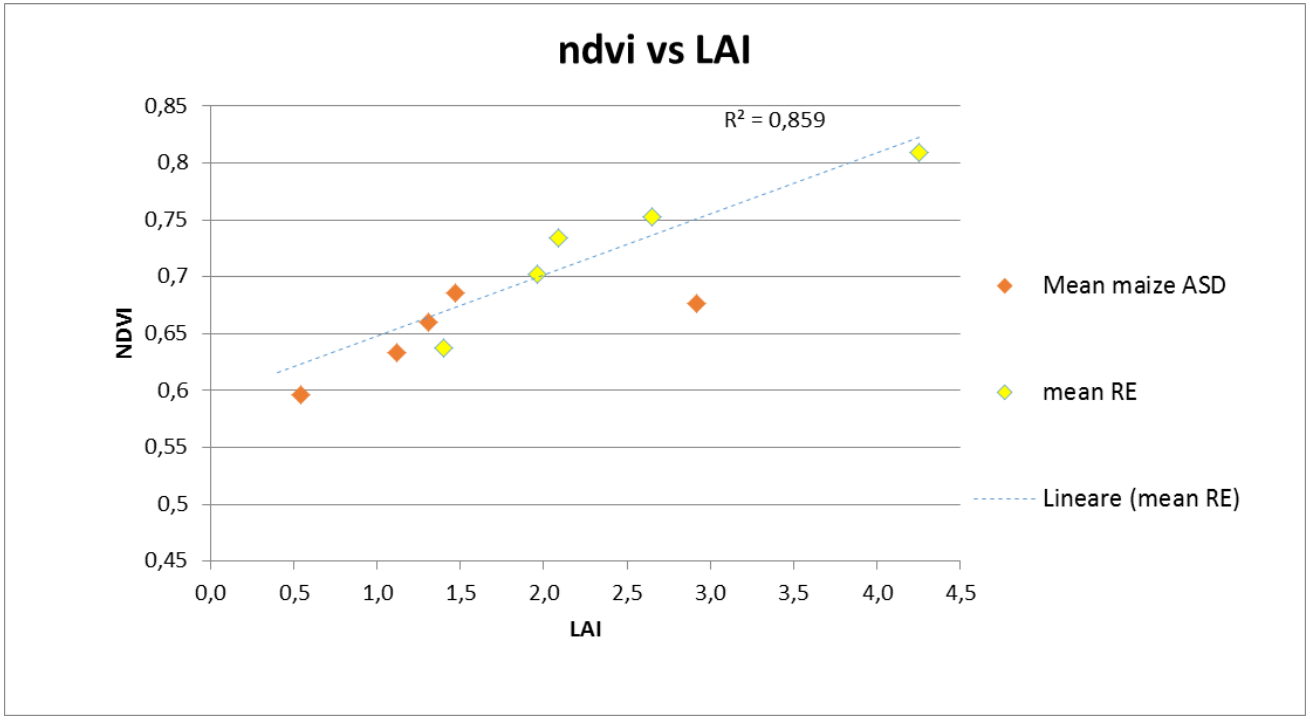
	RE
FCOVER (Bvnet)	72%
Soil (LMM)	30%
Total veg. (LMM)	49.35%

RE VI

									maize										meaan	devst
NDVI	0.76	0.70	0.73	0.67	0.61	0.72	0.78	0.74	0.63	0.77	0.77	0.82	0.81	0.82	0.80	0.80	0.82	0.79	0.75	0.07
SR	7.36	5.56	6.35	5.01	4.10	6.14	7.98	6.82	4.44	7.84	7.70	9.85	9.52	10.29	9.02	9.02	10.32	8.44	7.54	1.97
EVI	0.54	0.48	0.51	0.46	0.41	0.51	0.57	0.54	0.44	0.54	0.53	0.64	0.62	0.64	0.60	0.60	0.62	0.58	0.55	0.07
ARVI	0.67	0.57	0.61	0.54	0.46	0.61	0.70	0.65	0.49	0.66	0.66	0.73	0.71	0.73	0.71	0.71	0.75	0.69	0.65	0.08
Antho	6.82	5.99	7.02	5.46	4.57	7.68	7.30	7.46	5.09	8.31	7.94	7.08	7.20	6.90	7.38	7.46	7.97	8.27	6.99	1.06

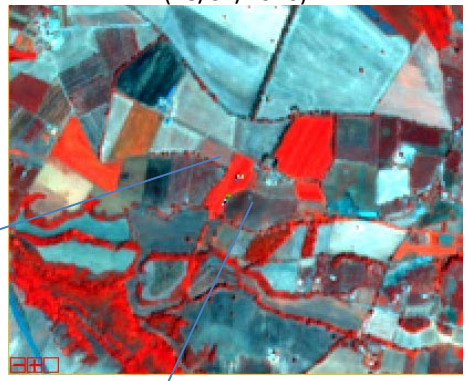
			weed			mean	devst
NDVI	0.72	0.71	0.71	0.65	0.78	0.71	0.05
SR	6.08	5.92	5.80	4.73	8.13	6.13	1.23
EVI	0.50	0.50	0.51	0.45	0.56	0.51	0.04
ARVI	0.60	0.60	0.60	0.53	0.69	0.60	0.06
Antho	7.32	6.20	6.49	5.17	7.82	6.60	1.03

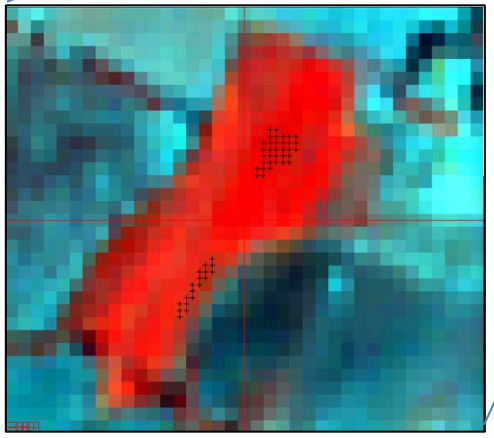
NDVI vs LAI: ASD ÷ RE

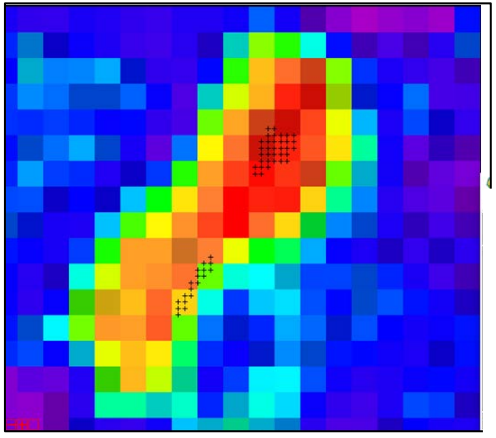


Sentinel-2 RGB and VI map

(18/07/2016)

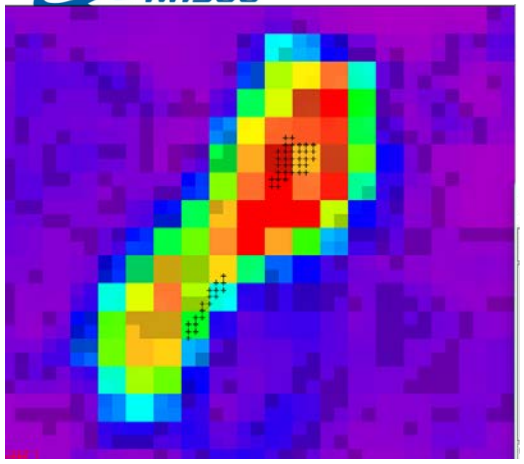


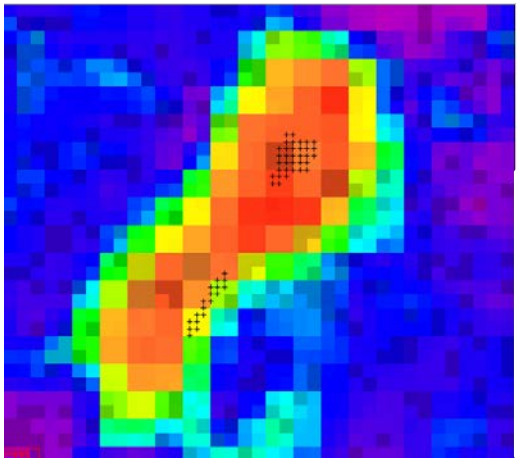


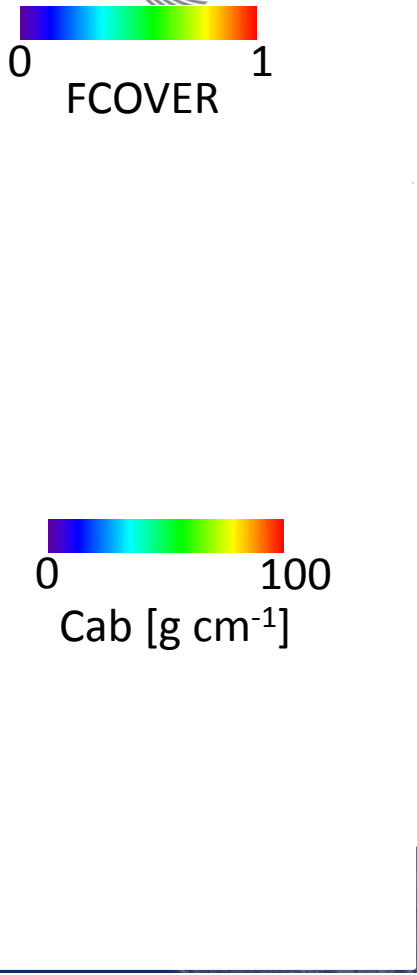


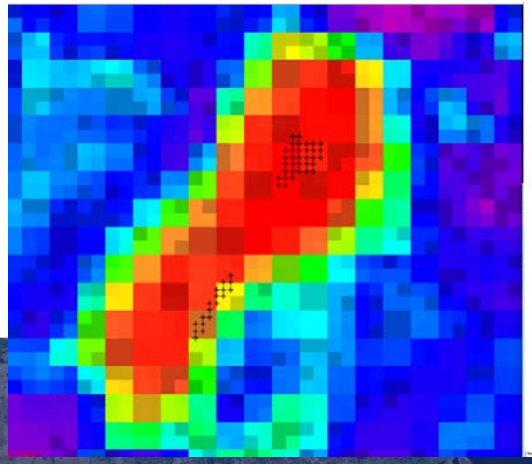
$$MRENDVI = \frac{\rho_{750} - \rho_{705}}{\rho_{750} + \rho_{705} - 2 * \rho_{445}}$$

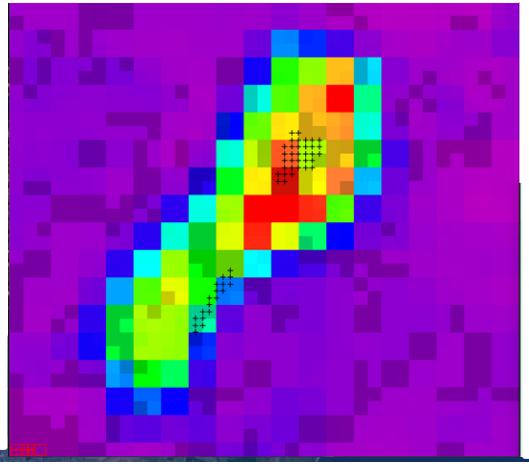
Sentinel-2 biophysical maps (ESA SNAP biophysical processor tool box)



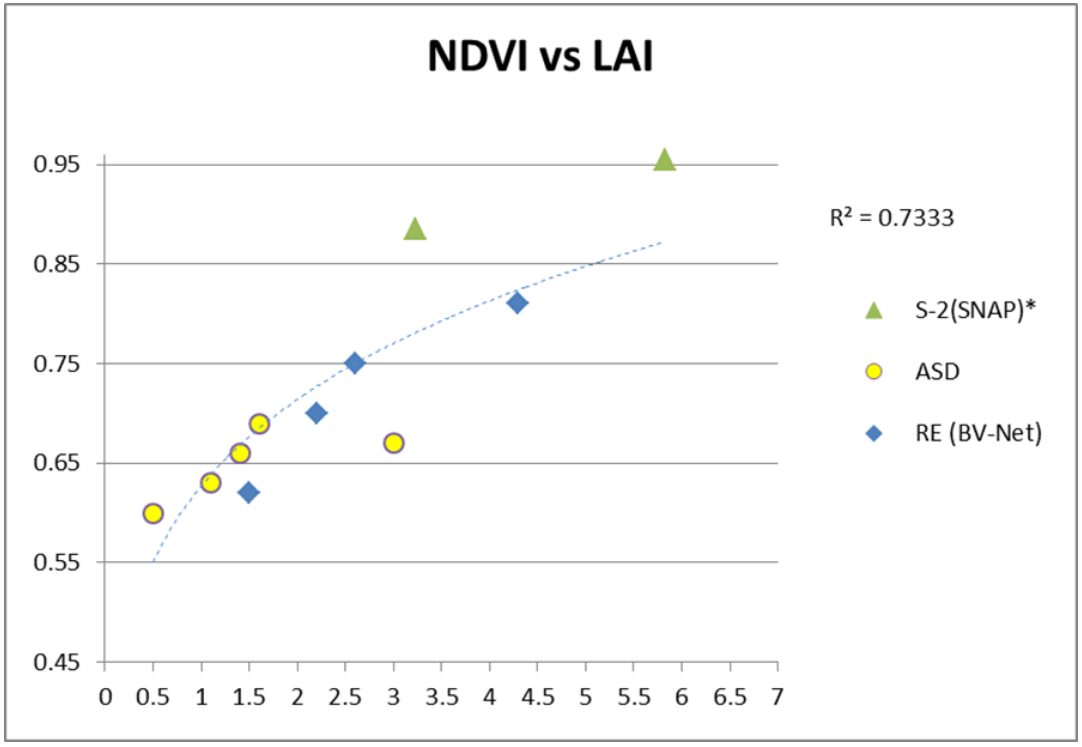








NDVI vs LAI: ASD, RE, S2



Conclusion

- A spectral library of the main weeds affecting in the test area maize and wheat has been defined;
- Same weed's bio-optical properties have been identified and appear to be suitable for their detection;
- Hyperspectral UAV data have allowed the detection of the crop/weeds affected zone by using both spectral index (including red-edge) and hard classification (SVM);
- RE @ 5m LAI and Cab need to be exploited to highlight areas potentially affected by weeds;
- S-2 (July acquisition) shows spectral characteristic suitable for weeds detection but spatial resolution seems inappropriate for the selected test site

Further studies

- Weed spectral library will be better populated to design more suitable spectral keys for weeds detection;
- Identify the Detection Limit of the weeds abundance within a S-2 pixel;
- Weeds recognition with hyperspectral UAV technologies.