

Update 14/12/17

Pilot project for tobacco mapping by remote sensing

Presentation of the results and the iTab platform



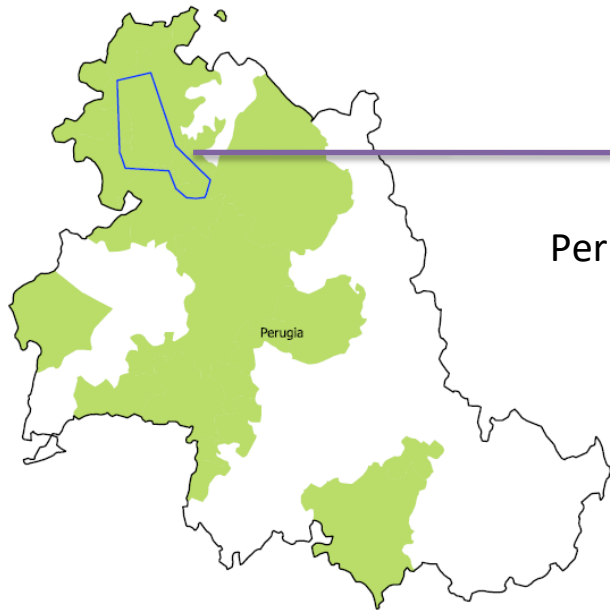
Phase 1 – Classification/mapping of tobacco growing areas

Phase 2 – “Mapped” vs. “declared” areas data analysis

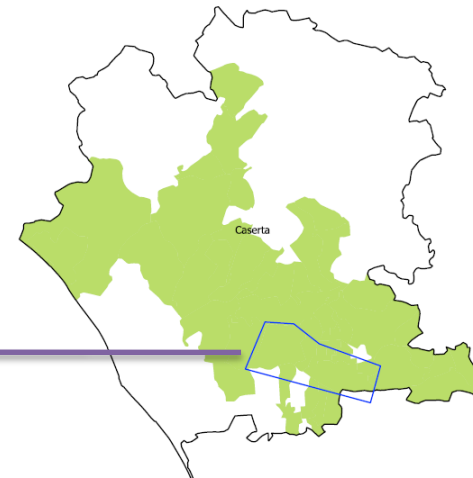
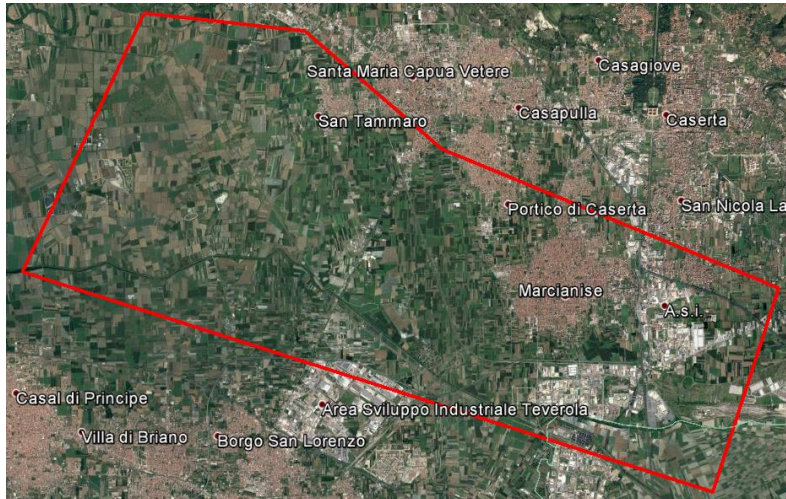
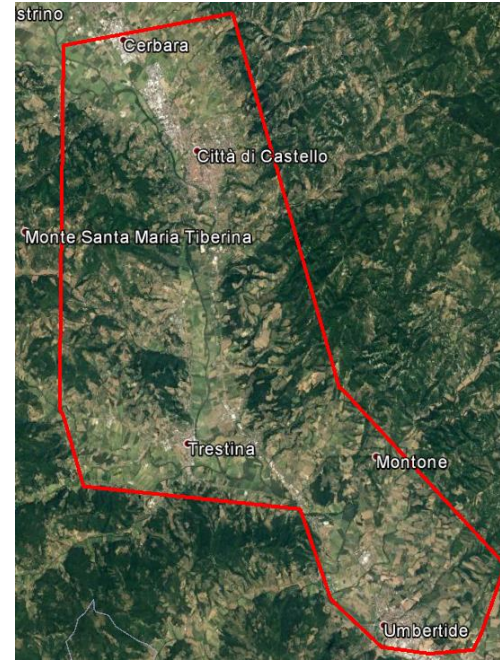
Phase 3 – Tobacco monitoring maps

Phase 4 – *iTab* platform development

Project pilot areas



Perugia (North) Area 160 Km²



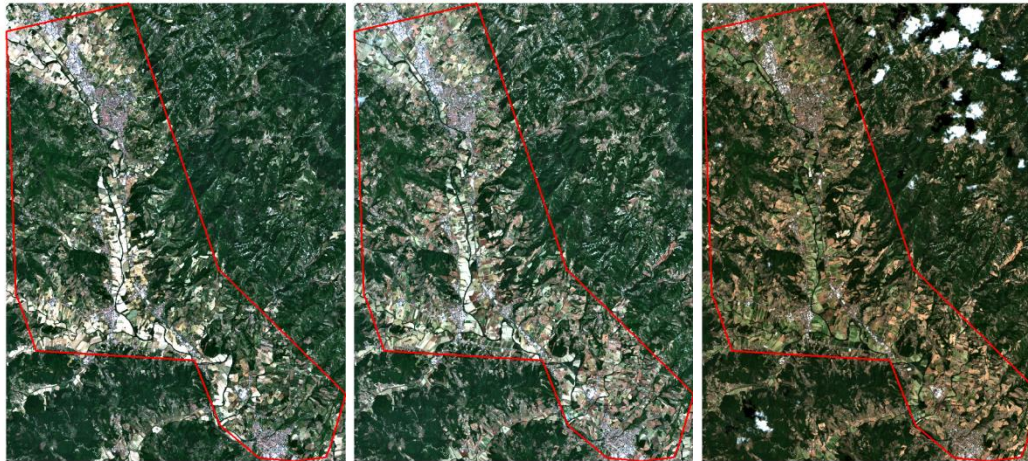
Caserta (South) Area 140 Km²

Phase 1 - Classification and mapping of tobacco growing areas

Acquisition of a multi-temporal series of three Sentinel2 satellite images for each study area

GPS survey in post transplantation

Acquisition of airplane data in very high resolution true colors



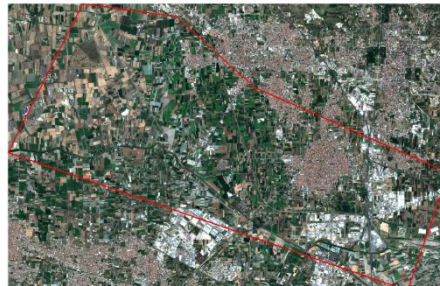
03/06/2017

23/06/2017

13/07/2017



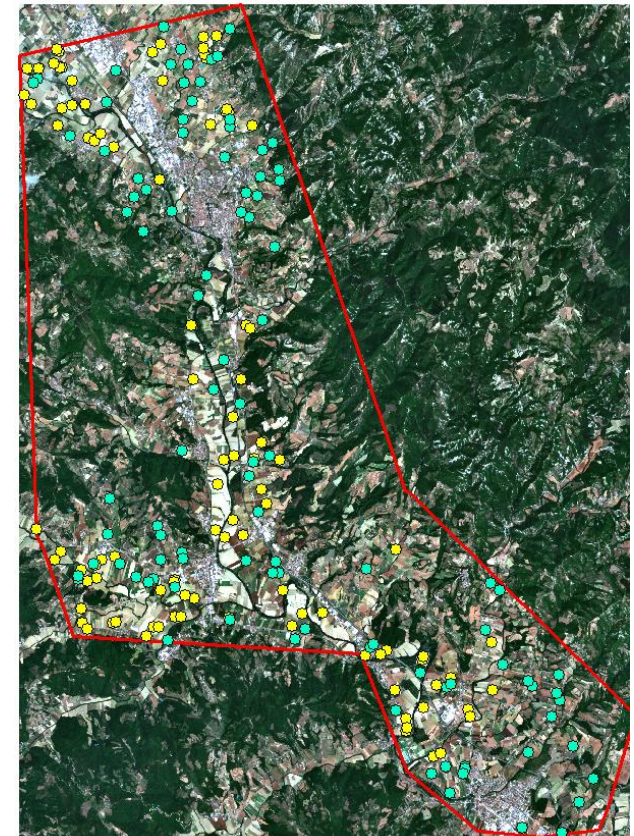
31/05/2017



20/06/2017

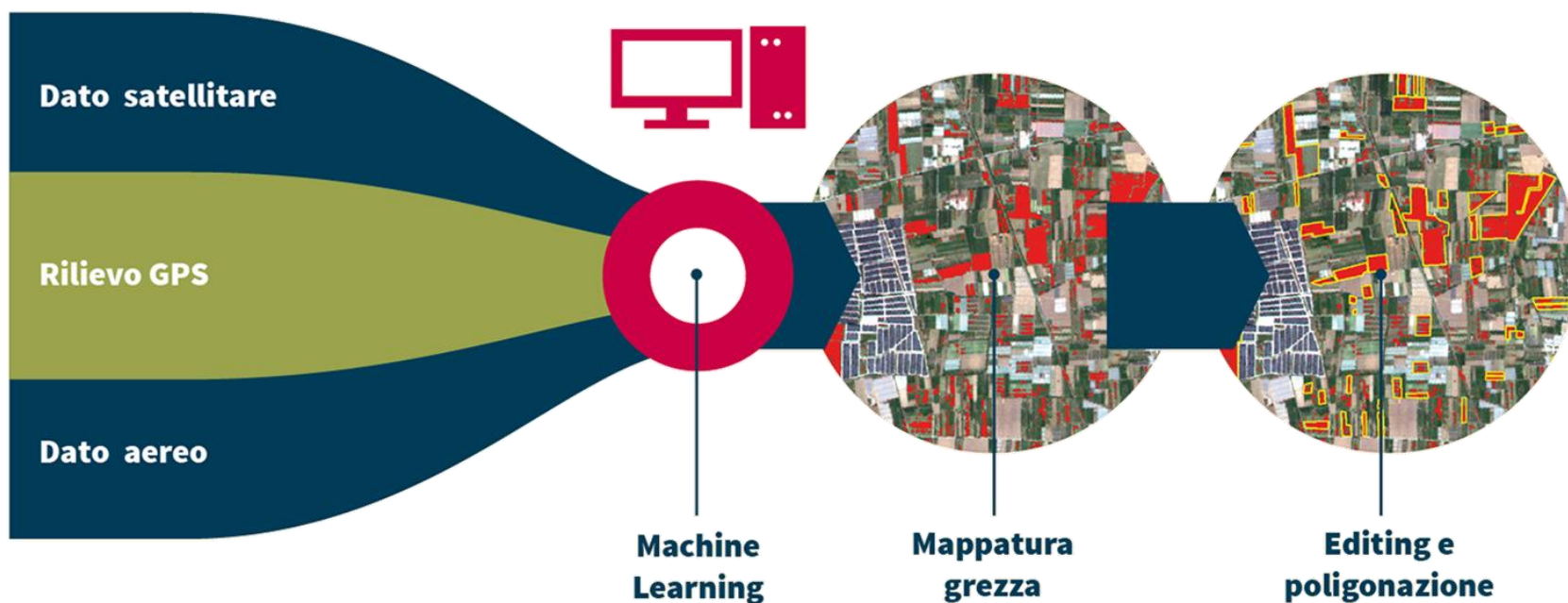


17/07/2017



Points of field surveys

Data processing methodology



Phase 1 – Classification and mapping of tobacco growing areas



Field survey



Classification through
machine learning



Refining and Polygonation



Final classification result

CLASSIFICATION ACCURACY CALCULATED BY REAL ON GROUND DATA

NORTH AREA

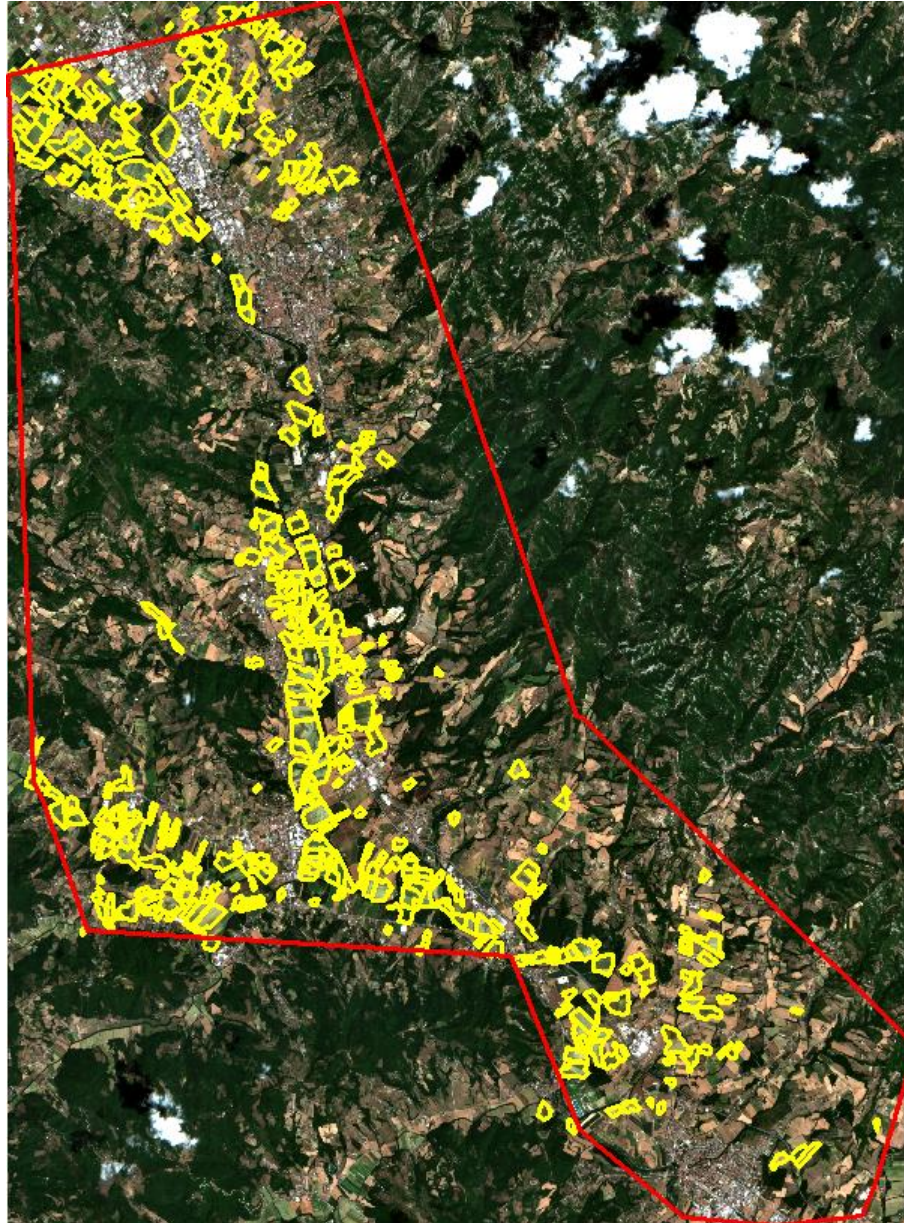
Image date	Accuracy
03/06/20417	59%
23/06/2017	95%
13/07/2017	91%

SOUTH AREA

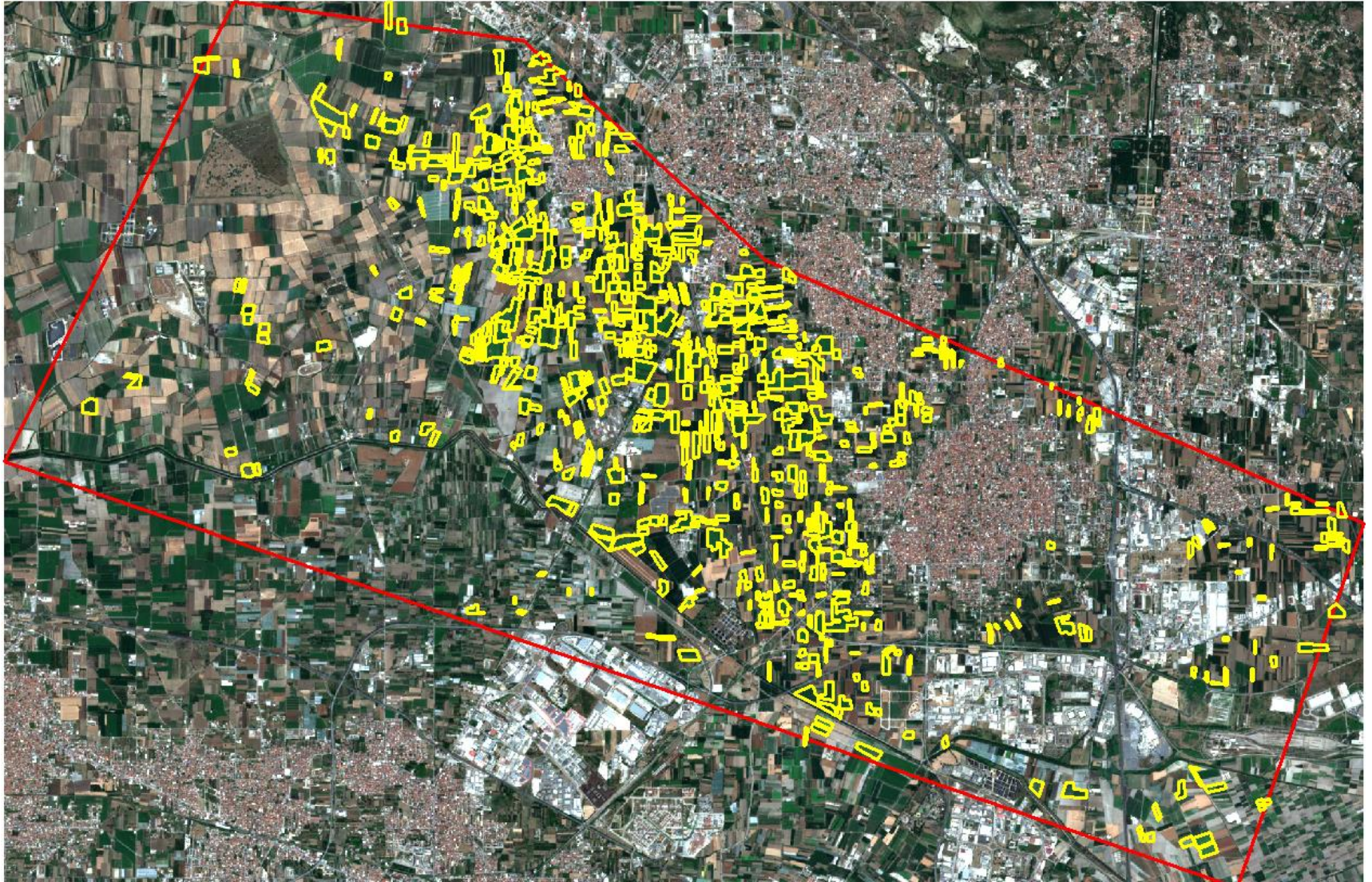
Image date	Accuracy
31/05/2017	80%
20/06/2017	85%
17/07/2017	93%

The best time window found highlighted in green

NORTH AREA TOBACCO MAPPING UPON IMAGE OF 23/6/2017



SOUTH AREA TOBACCO MAPPING UPON IMAGE OF 17/07/2017



Phase 2 – “Mapped” data vs “declared” (AGEA provided) data analysis

The “declared” data have been checked and standardized, resolving some inconsistencies on doubled data

Identification of each record and mapping of cadastral parcels on the *open land registry* portal webgis Umbria

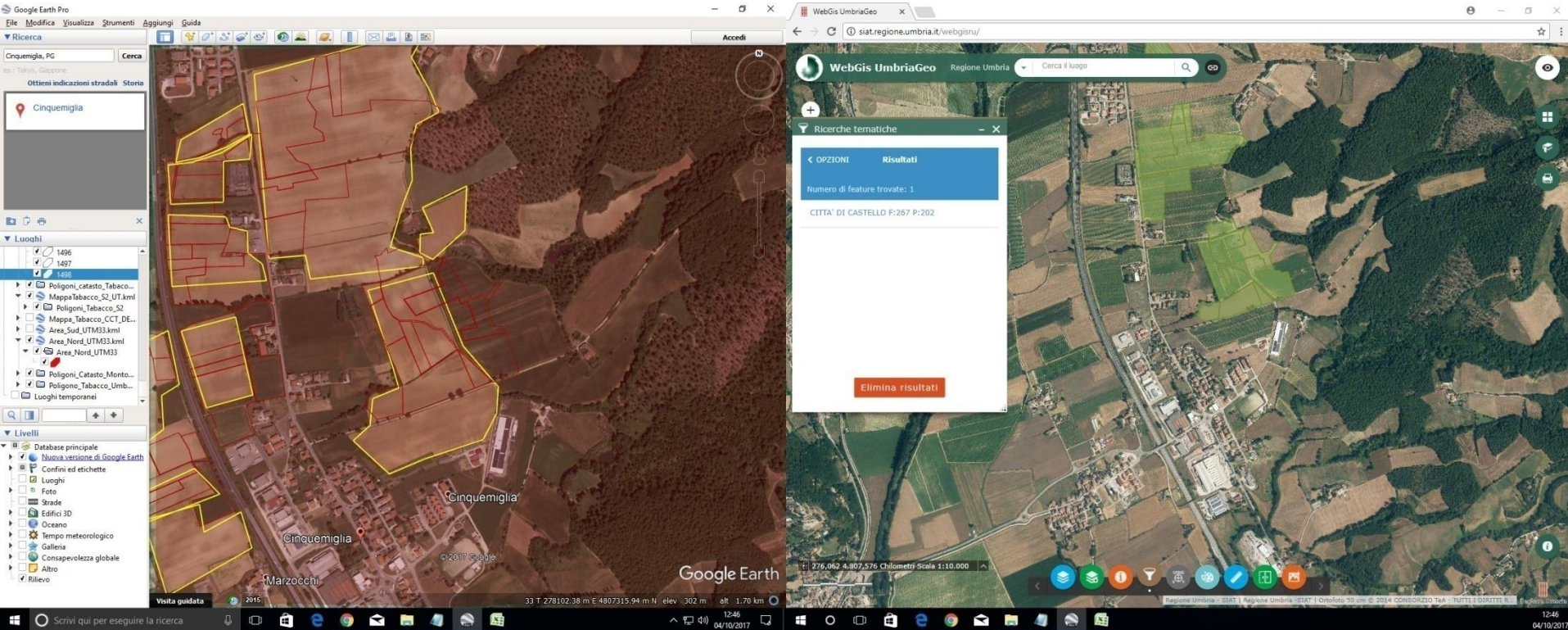
Critical issues:

- more than 3% of the parcels do not find correspondence on the webgis portal which integrates a cadastral data updated to 2000
- to date, the possibility of consulting the relevant land registry of the Campania area is missing

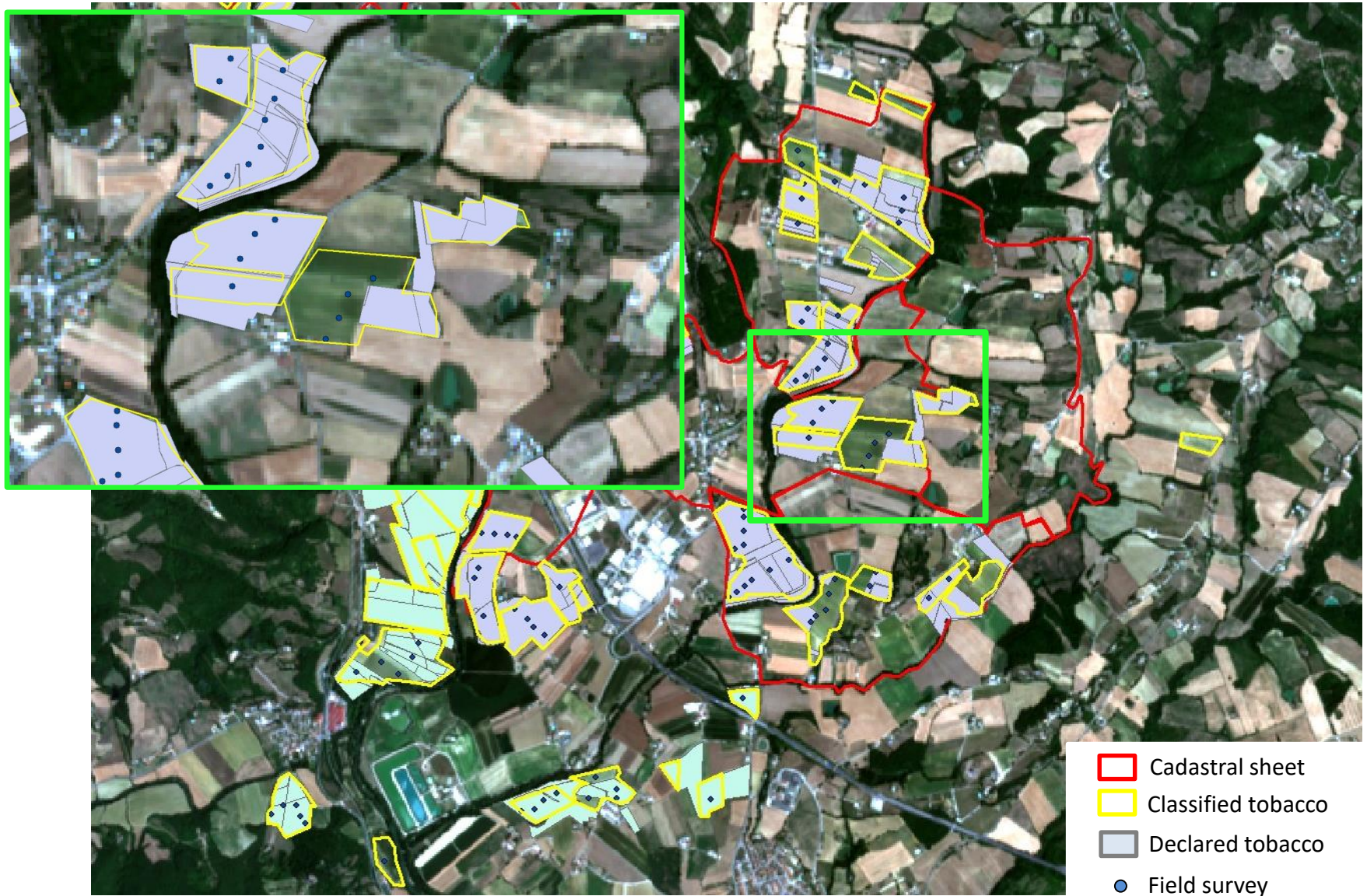
Evaluation between mapped data vs declared data was made:

- on a municipal basis (only 100% mapped municipalities) for Campania and Umbria
- on cadastral sheet (Umbria only)
- by island / parcel (Umbria only)

Agea data mapping on the UmbriaGeo WebGIS platform



Agea data mapping



Evaluation between *mapped* vs. *declared* data

At the Municipality level

(only on 100% mapped Municipalities)

Municipality	Municipality hectares	Tobacco classified hectares	% Municipal mapped area	AGEA declared hectares	Hectares difference	% Diff.
San Tammaro	3679.85	319.30	99.8 %	290.52	28.78	+9.91%
Portico di Caserta	190.346	6.48	93.3 %	7.024	-0.54	-7.67%
Capodrise	344.60	16.80	100 %	19.70	-2.9	-14.74%
Marcianise	3006.42	183.36	99.4 %	181.24	2.12	+1.17%

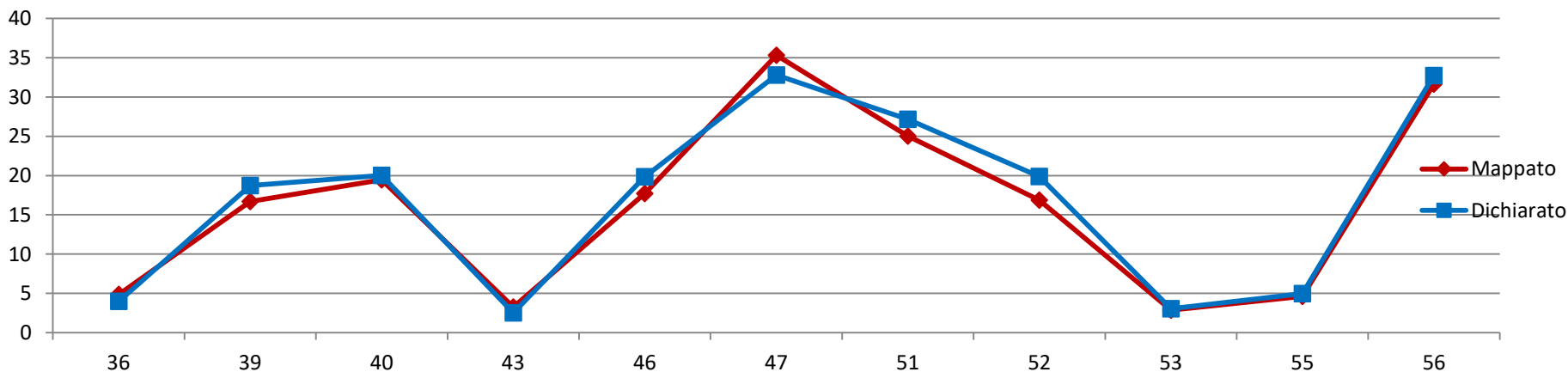
Municipality	Municipality hectares	Tobacco classified hectares	% Municipal mapped area	AGEA declared hectares	Hectares difference	% Diff.
Montone	5105.91	186.68	Dato parziale	195.54	- 8.86	-4.5%

Evaluation between *mapped* vs. *declared* data

At the level of cadastral sheet

(Analysis carried out only on the sheets in which all the cadastral parcels were found)

Province	Municipality	Sheet	Declared Ha	Mapped Ha	Difference	% difference
Perugia	Montone	36	3.97	4.85	0.88	22.1%
Perugia	Montone	39	18.73	16.71	-2.02	-10.8%
Perugia	Montone	40	20.02	19.45	-0.58	-2.9%
Perugia	Montone	43	2.53	3.26	0.72	28.6%
Perugia	Montone	46	19.83	17.69	-2.14	-10.8%
Perugia	Montone	47	32.80	35.32	2.52	7.7%
Perugia	Montone	51	27.18	25.02	-2.16	-7.9%
Perugia	Montone	52	19.89	16.88	-3.00	-15.1%
Perugia	Montone	53	3.05	2.86	-0.19	-6.3%
Perugia	Montone	55	4.96	4.63	-0.34	-6.8%
Perugia	Montone	56	32.73	31.63	-1.10	-3.4%
			185.70	178.31	-7.39	-4.0%

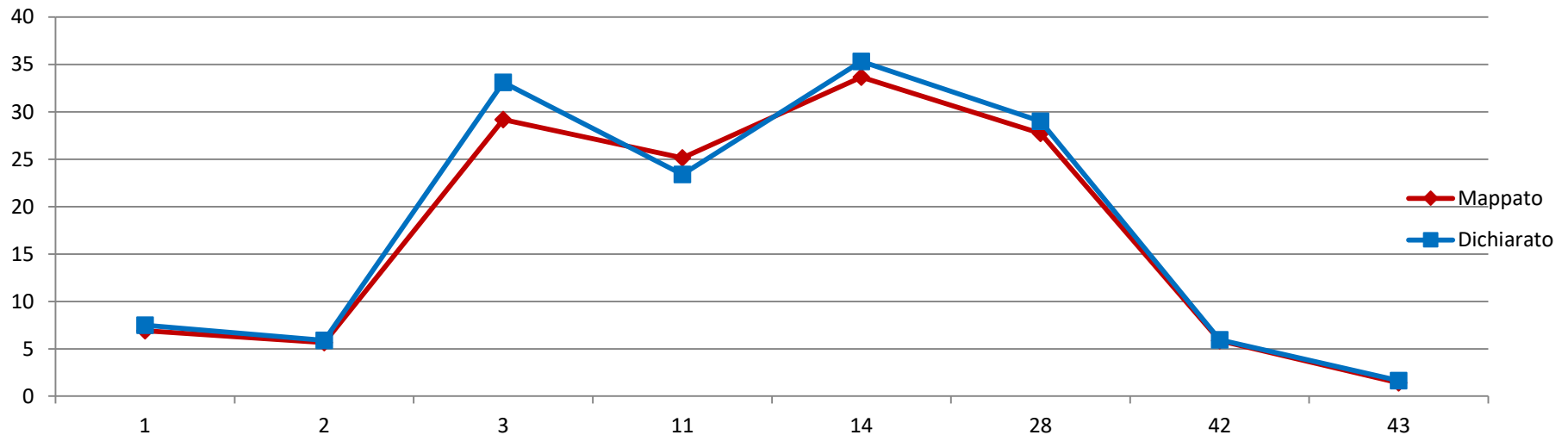


Evaluation between *mapped* vs. *declared* data

At the level of cadastral sheet

(Analysis carried out only on the sheets in which all the cadastral parcels were found)

Province	Municipality	Sheet	Declared Ha	Mapped Ha	Ha difference	% differenza
Perugia	Umbertide	1	7.49	6.91	-0.58	-7.8%
Perugia	Umbertide	2	5.87	5.65	-0.23	-3.8%
Perugia	Umbertide	3	33.09	29.18	-3.92	-11.8%
Perugia	Umbertide	11	23.39	25.13	1.75	7.5%
Perugia	Umbertide	14	35.30	33.65	-1.65	-4.7%
Perugia	Umbertide	28	29.01	27.73	-1.28	-4.4%
Perugia	Umbertide	42	5.93	5.85	-0.08	-1.3%
Perugia	Umbertide	43	1.64	1.42	-0.22	-13.4%
			141.73	135.52	-6.20	-4.4%



Evaluation between *mapped* vs. *declared* data

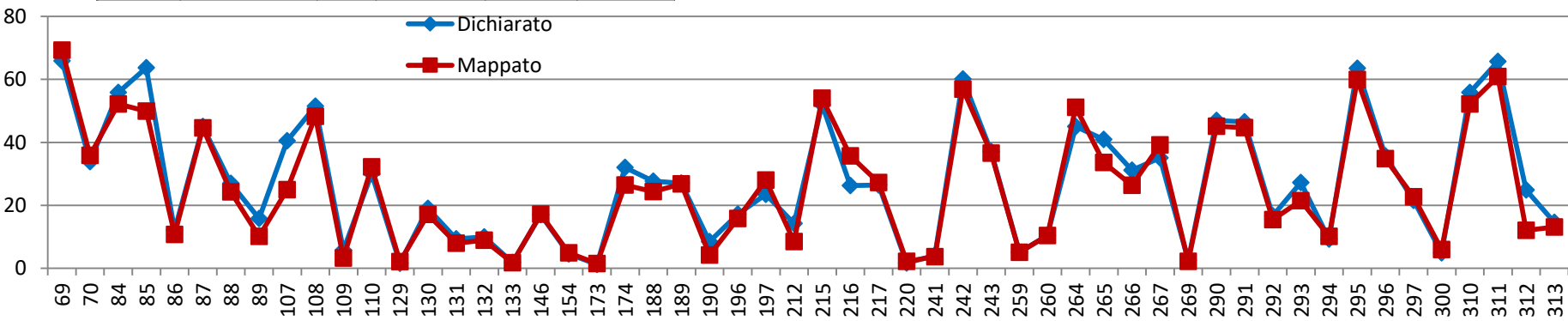
At the level of cadastral sheet

(Analysis carried out only on the sheets in which all the cadastral parcels were found)

Province	Municipality	Sheet	Declared Ha	Mapped Ha	Difference	% difference
Perugia	Città di Castello	69	65.89	69.27	3.38	5.1%
Perugia	Città di Castello	70	33.86	35.88	2.02	6.0%
Perugia	Città di Castello	84	55.83	52.20	-3.63	-6.5%
Perugia	Città di Castello	85	63.73	49.88	-13.85	-21.7%
Perugia	Città di Castello	86	12.07	10.73	-1.34	-11.1%
Perugia	Città di Castello	87	45.01	44.56	-0.46	-1.0%
Perugia	Città di Castello	88	26.98	24.22	-2.76	-10.2%
Perugia	Città di Castello	89	15.75	10.15	-5.60	-35.6%
Perugia	Città di Castello	107	40.50	24.97	-15.53	-38.3%
Perugia	Città di Castello	108	51.45	48.29	-3.16	-6.1%
Perugia	Città di Castello	109	5.74	3.22	-2.52	-43.9%
Perugia	Città di Castello	110	29.97	32.17	2.20	7.3%
Perugia	Città di Castello	129	1.56	2.07	0.50	32.0%
Perugia	Città di Castello	130	18.99	17.06	-1.92	-10.1%
Perugia	Città di Castello	131	9.33	7.89	-1.44	-15.4%
Perugia	Città di Castello	132	9.97	8.92	-1.05	-10.5%
Perugia	Città di Castello	133	1.85	1.77	-0.08	-4.3%
Perugia	Città di Castello	146	17.04	17.15	0.11	0.7%
Perugia	Città di Castello	154	4.51	4.89	0.38	8.4%
Perugia	Città di Castello	173	1.23	1.43	0.20	16.7%
Perugia	Città di Castello	174	32.04	26.44	-5.60	-17.5%
Perugia	Città di Castello	188	27.68	24.35	-3.32	-12.0%
Perugia	Città di Castello	189	27.03	26.81	-0.22	-0.8%
Perugia	Città di Castello	190	8.46	4.20	-4.26	-50.4%
Perugia	Città di Castello	196	17.16	15.79	-1.38	-8.0%
Perugia	Città di Castello	197	23.46	28.04	4.57	19.5%
Perugia	Città di Castello	212	14.21	8.46	-5.75	-40.5%

Province	Municipality	Sheet	Declared Ha	Mapped Ha	Difference	% difference
Perugia	Città di Castello	215	51.96	53.98	2.02	3.9%
Perugia	Città di Castello	216	26.30	35.72	9.42	35.8%
Perugia	Città di Castello	217	26.42	27.20	0.79	3.0%
Perugia	Città di Castello	220	1.61	2.20	0.59	36.6%
Perugia	Città di Castello	241	4.07	3.62	-0.45	-11.1%
Perugia	Città di Castello	242	60.14	56.90	-3.25	-5.4%
Perugia	Città di Castello	243	37.12	36.53	-0.58	-1.6%
Perugia	Città di Castello	259	5.05	5.02	-0.03	-0.7%
Perugia	Città di Castello	260	10.43	10.35	-0.09	-0.8%
Perugia	Città di Castello	264	44.98	51.13	6.15	13.7%
Perugia	Città di Castello	265	40.91	33.63	-7.28	-17.8%
Perugia	Città di Castello	266	31.14	26.32	-4.81	-15.5%
Perugia	Città di Castello	267	35.05	39.21	4.16	11.9%
Perugia	Città di Castello	269	2.54	2.17	-0.37	-14.6%
Perugia	Città di Castello	290	46.97	45.14	-1.83	-3.9%
Perugia	Città di Castello	291	46.48	44.69	-1.80	-3.9%
Perugia	Città di Castello	292	16.65	15.40	-1.25	-7.5%
Perugia	Città di Castello	293	27.23	21.44	-5.79	-21.3%
Perugia	Città di Castello	294	9.25	10.11	0.85	9.2%
Perugia	Città di Castello	295	63.53	59.95	-3.58	-5.6%
Perugia	Città di Castello	296	35.64	34.78	-0.86	-2.4%
Perugia	Città di Castello	297	21.51	22.64	1.13	5.3%
Perugia	Città di Castello	300	4.91	5.95	1.04	21.2%
Perugia	Città di Castello	310	55.82	52.19	-3.63	-6.5%
Perugia	Città di Castello	311	65.67	60.94	-4.74	-7.2%
Perugia	Città di Castello	312	24.85	12.00	-12.85	-51.7%
Perugia	Città di Castello	313	14.55	13.08	-1.47	-10.1%

1472.09 1383.08 -89.01 -6.0%



Evaluation between *mapped* vs. *declared* data

At Island / cadastral parcel level



Evaluation between *mapped* vs. *declared* data

At Island / cadastral parcel level



- Declared tobacco
- Classified tobacco
- Field survey

Evaluation between *mapped* vs. *declared* data

At Island / cadastral parcel level



Classified Ha:
27.98

Declared Ha:
28.07

- 0.09 Ha

-  Cadastral sheet
-  Classified tobacco
-  Declared tobacco

Evaluation between *mapped* vs. *declared* data

At Island / cadastral parcel level



Classified Ha:
23.15

Declared Ha:
24.37

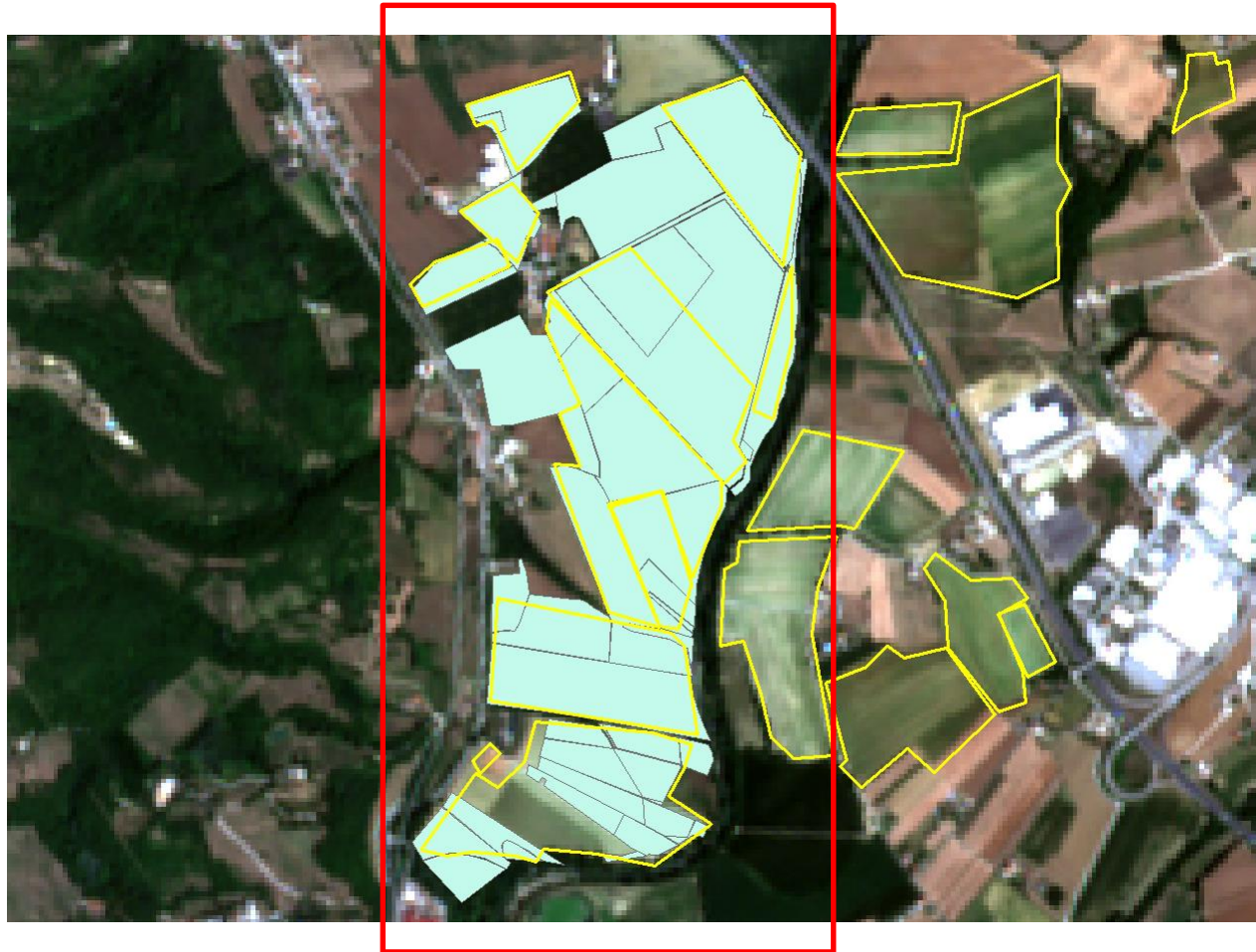
-  Cadastral sheet
-  Classified tobacco
-  Declared tobacco

Classified Ha:
15.13

Declared Ha:
15.76

Evaluation between *mapped* vs. *declared* data

At Island / cadastral parcel level



-  Cadastral sheet
-  Classified tobacco
-  Declared tobacco

Classified Ha:
27.98

Declared Ha:
28.07

- 0.09 Ha

Valutazione tra dato *mappato* vs *dichiarato*

Identification of undeclared tobacco?

(to be checked in case the parcel not found/matching on the cadastral webgis system)



- Declared tobacco
- Classified tobacco
- Field Survey

Phase 3 - Tobacco monitoring maps

NDVI - Normalized Difference Vegetation Index



Heathy Vegetation Reflectance

50% NIR
8% Red



NDVI = 0.72

Stressed Vegetation Reflectance

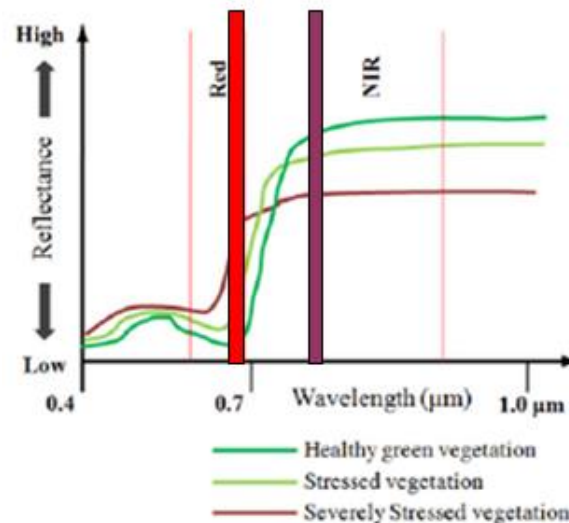
40% NIR
30% Red



NDVI = 0.14

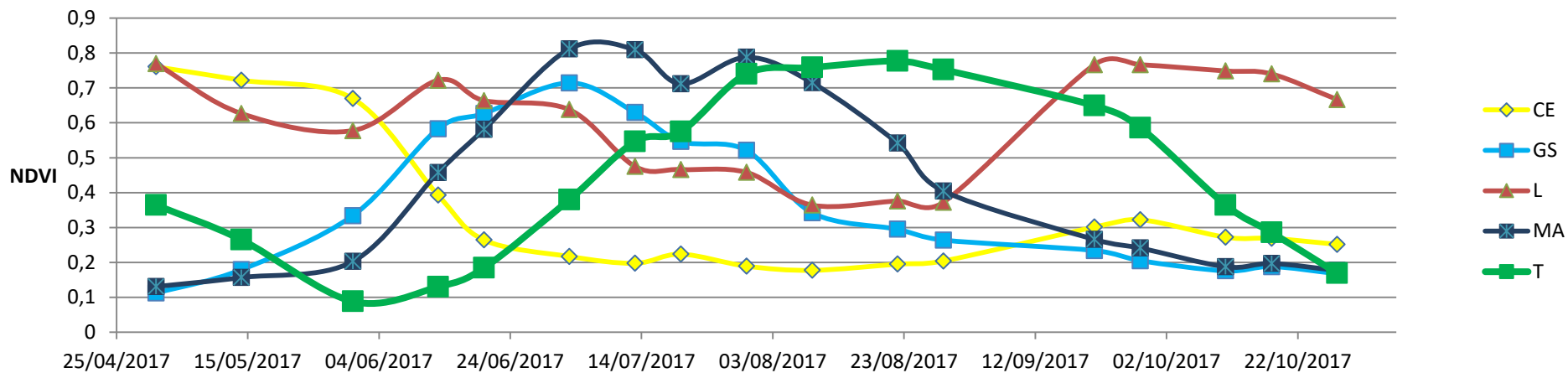
$$\text{NDVI} = \frac{\text{NIR} - \text{Red}}{\text{NIR} + \text{Red}}$$

Index variable between -1 and 1

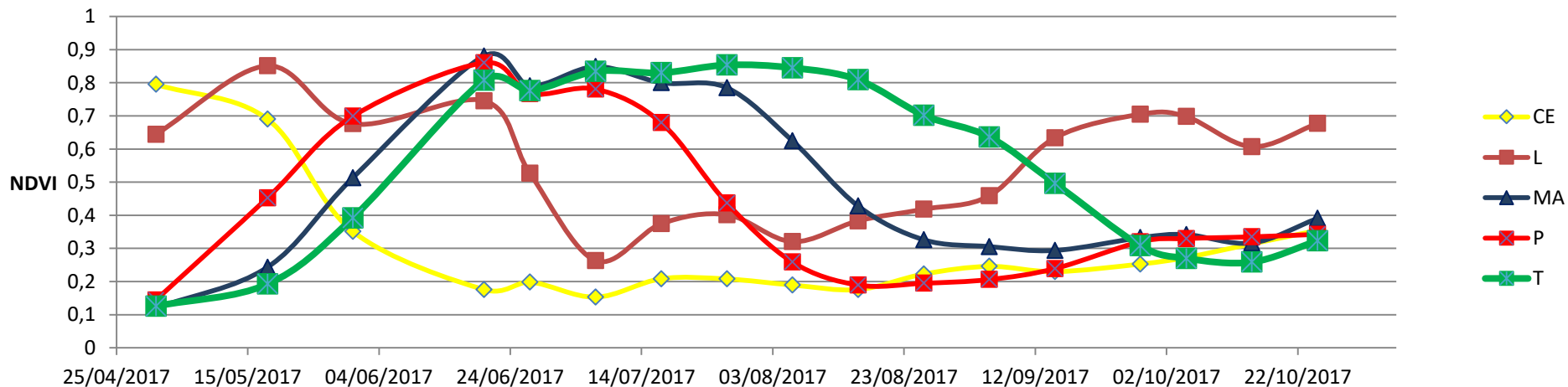


NDVI trend for the main crops

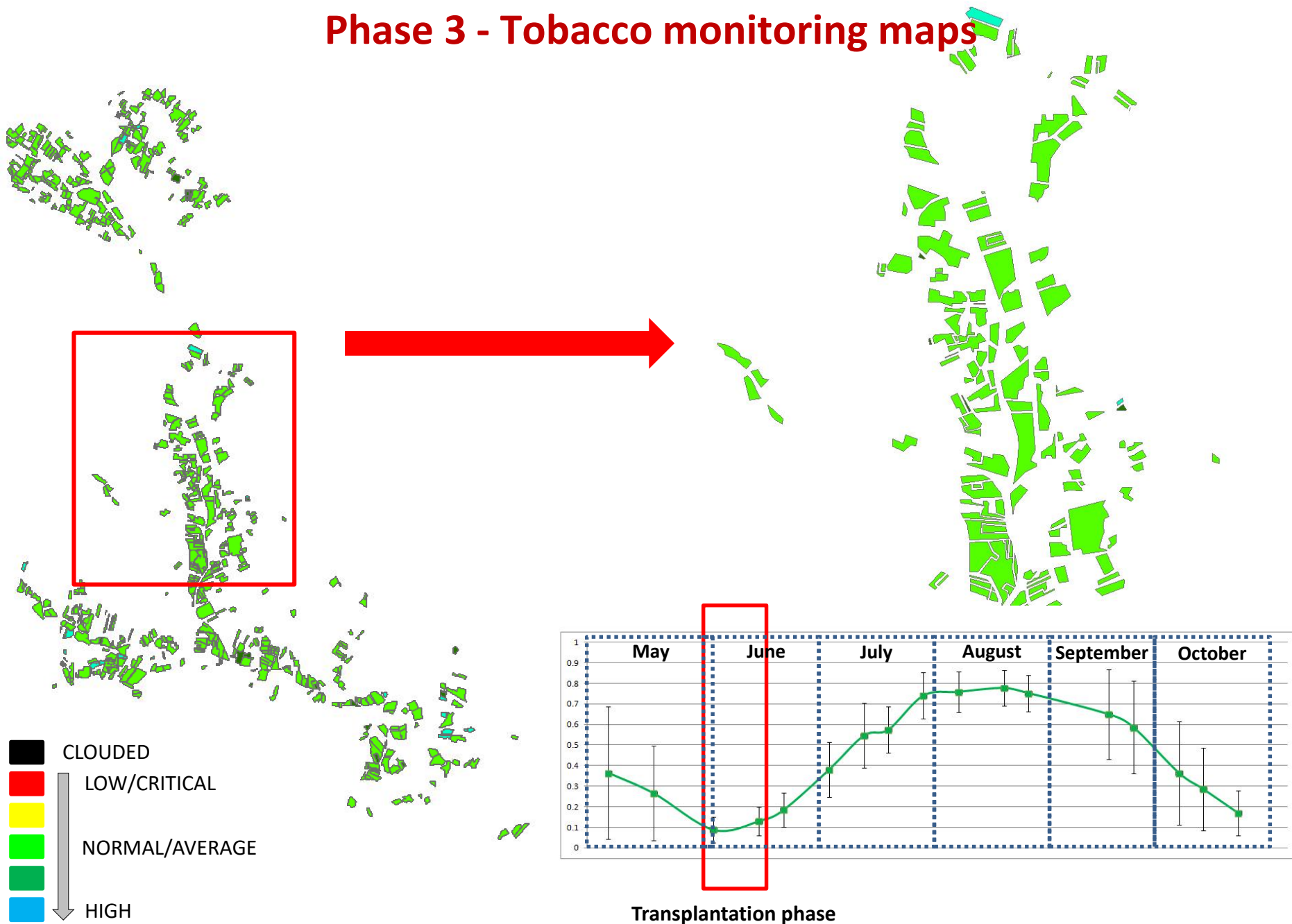
North Area - Umbria



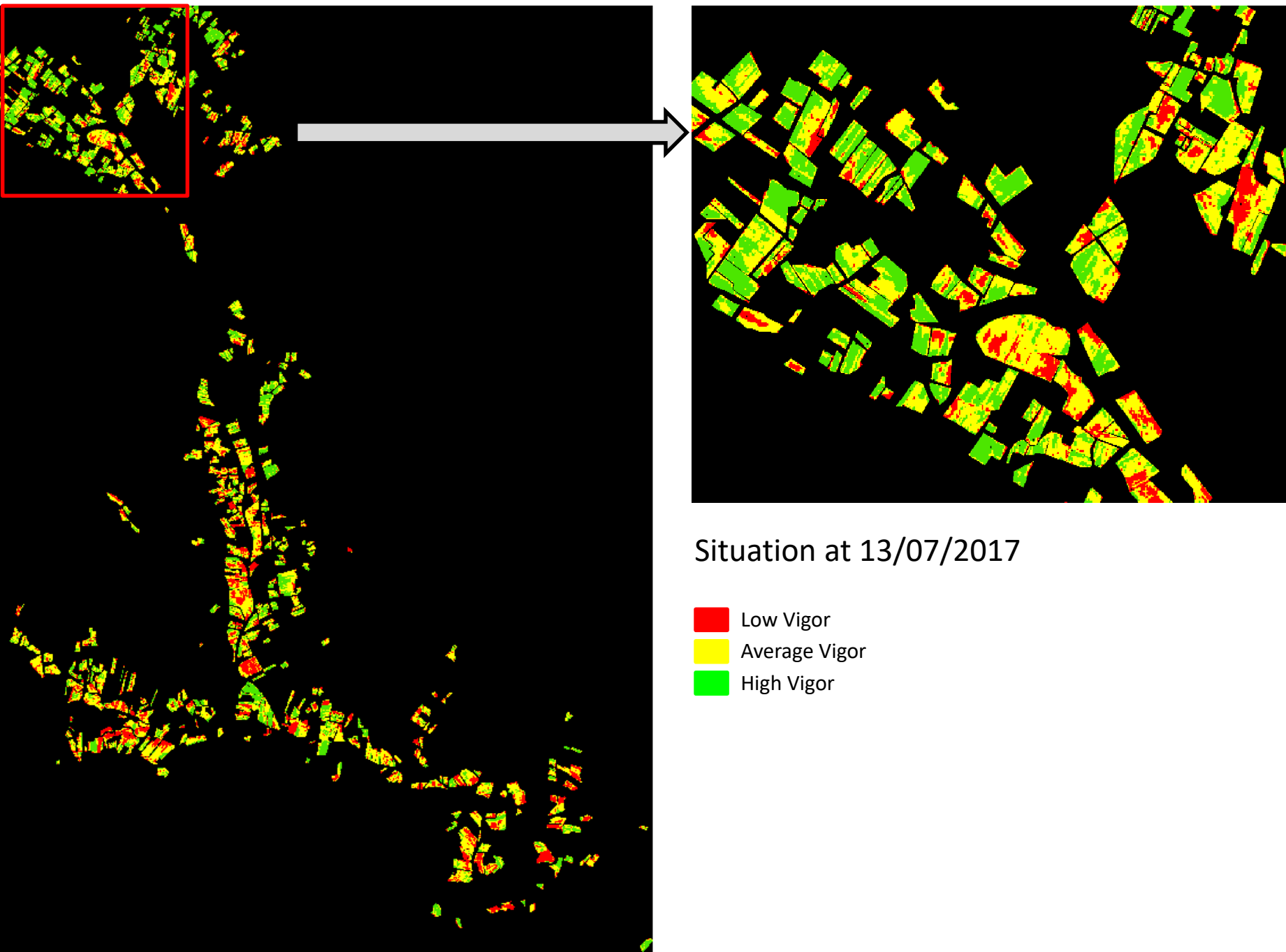
South Area - Campania



Phase 3 - Tobacco monitoring maps



Phase 3 – Vigor maps

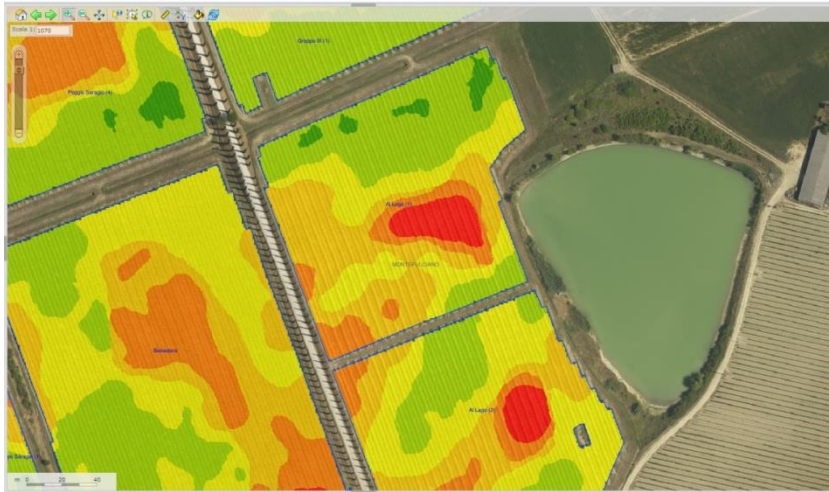


Variable Rate Technology (VRT) Fertilization

Analysis of time series remotely sensed data
Expectation Maximization Clustering



Mapping of soil variability and
production potential



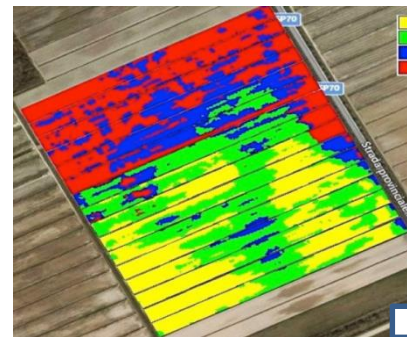
Microelements (N, P, K)
balancing model

Prescription maps for VRT
fertilization



Interventions on covering fertilization

Rateo-variable fertilizer spreader
with maps reading GPS system



Variable Rate fertilization tests
on experimental plots
(2° year)

Phase 4 - *iTab* platform development



SISTEMA INFORMATIVO PER LA MAPPATURA
E IL MONITORAGGIO DEL TABACCO



TABACCO ITALIA
Organizzazione Interprofessionale

AREA UMBRIA AREA CAMPANIA

Cerca

- Basi cartografiche**
 - Google maps
 - ☐ Satellite
 - ☒ Strade
 - ☐ Ibrida
 - ☐ Rilievo
 - Cartografia
 - ☒ Aree di studio
 - ☒ Comuni
 - ☐ Fogli catasto (Umbria)
 - ☐ Particelle catasto (Umbria)
 - ☐ Catasto WMS Umbria
- Mappe tabacco**
 - Mappe coltivazioni tabacco
 - ☒ Mappa tabacco 2017
 - Immagini satellitari
 - ☒ SentinelII ago2017
 - Mappe di vigore
 - ☐ Mappe di vigore 3 classi
 - Rilievi in campo
- Mappe monitoraggio**
 - Mappe monitoraggio
 - Satellitari monitoraggio



200 m 500 m

Scale = 1 : 1.04
Data: 12/01/2017 15:53:01



[Link to iTab](#)

Closing remarks

The Sentinel data allows a **correct classification of tobacco**. The results of accuracy (assessed with data found on the fields) achieved in both Umbria and Campania (with the check campaign it **exceeds 95% of accuracy**), where different varietal groups and different cultivation conditions prevail are considered excellent. The spectral data of tobacco has a high separability with all other crops (especially in Umbria). **Some classification errors are also recovered during the mapping refining phase.**

At island level, the difference between the mapped and declared surfaces is in the order of half hectare (in Umbria). At municipal level there are differences that fall within 10 hectares (except for San Tammaro which must be verified). **These deviations are considered to be completely compatible with the project assumptions** and the main reasons for these differences would appear to be attributable to:

- polygonation accuracy for low geometric resolution (and consequent representation scale) of the remote sensing data (resolution of 10m) as well as sporadic classification errors that would tend to underestimate the surfaces of few percentage points
- accuracy of the declared data that refers to a given cadastral land registry that often does not follow the real “land use” geometries and is declared in advance net of the cultivation problems and of the crop success.

Closing remarks

A difficult question: which surface data can be considered more accurate, TLR or declared?

Criticality: the possibility of using the TLR data to highlight illegal tobacco growing is subject to an effective (automatic?) georeferencing system of the declaration data. The Italian Fiscal Agency has recently published a first open data service for the cadastral survey that is being developed. Another possibility could be the use of platforms such as the SIM (Mountain Information System)

Activity: having the mapping from TLR and the declared data available, would be a valid support to the control activity, allowing to quickly verify in the field any undeclared production units.

In addition to the controls, the *iTab* platform could provide additional services to the various actors in the supply chain, being able to centralize a powerful geographical database of tobacco growing (tobacco cadastre) and activate a system of dynamic monitoring of the crop.

The calibration of the control maps of the vegetative conditions could be done over time having available the cultivation data of a sample of georeferenced production units in order to return further information of an agronomic nature (for example fertilization maps, production maps, etc.).