ERMES
AN EARTH OBSERVATION MODEL BASED RICE INFORMATION SERVICE

ERMES: MONITORING THE RICE GROWING SEASON FROM SATELLITE AND METEO DATA

Speakers: Lorenzo Busetto, Daniela Stroppiana (CNR-IREA)

Main Contributors

Dimitris Stavrakoudis, Hana Minakou, Ioannis Gitas(AUTH)
Manuel Campos, Goncal Grau, Javier Garcia Haro (UVEG)
Francesco Holecz, Massimo Barbieri, Luca Gatti (SARMAP)
Elisabetta Ricciardelli, Mariassunta Viggiano, Francesco Di Paola, Filomena Romano (IMAA)
Mirco Boschetti, Lorenzo Busetto, Alberto Crema, Francesco Nutini, Luigi Ranghetti , Daniela Stroppiana(IREA)
Roberto Confalonieri,Valentina Pagani, Tommaso Guarneri, Carlo Gilardelli, Ermes Movedi(UMIL)
Ignacio Miralles, Carlos Granell, Sven Casteleyn (UJI)

ERMES Regional Rice Service & products - in a nutshell

Regional authorities and some branches of the private sector (e.g., traders and milling Industries) need updated figures on the ongoing season, such as forecast of the production and indication of potential risks that can impact on the yield (and quality) of crops products on the market.
RRS is intended to provide **near real time crop monitoring information** and tools, regional **yield forecasting** and end of season estimation, and biotic and abiotic **risks alerting**.

Products generation

- Rice mapping and flood monitoring
- Phenology mapping and analyses
- Meteo data
- Biophysical parameters (LAI, EF)
- Biotic Risk modelling and alerting
- Rice yield forecasting

Service deployment

RRS

- Automation of processing chains, deployment and dissemination
- Quality check and fitness for use analysis
- Constant interaction with end-users
- Deployment through ERMES GeoPortal and/or provision of dedicated post-processed products

ERMES

Rice mapping, agro-practices and flooding occurrence

Copernicus

❖ Usefulness for regional monitoring authorities

- Get early estimates of rice-invested areas in each year
- Mapping of rice cultivated areas in relation to agro-practices (Dry vs Water sowing);

  - Servizio fitosanitario of Lombardy Region is required to monitor rice cultivations !
    - COUNCIL DIRECTIVE 2000/29/EC of 8 May 2000 on protective measures **against the introduction into the Community of organisms harmful to plants or plant products** and against their spread within the Community
    - COMMISSION IMPLEMENTING DECISION of 8 November 2012 as regards measures **to prevent the introduction into and the spread within the Union of the genus Pomacea** (Perry) (notified under document C(2012) 7803) (2012/697/EU)

  - Satellite rice crop/flooding mapping useful to plan field operators work:
    - e.g., relate rice cultivations positions with potential sources of phitosanitary risk (e.g., companies involved in production of acquarium plants)
    - Relate rice cultivations with main rivers positions
    - Verify spatial distributiuon of monitored rice parcels to check if they are «representative» of the main characteristics of the rice cultivation areas

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❖ Usefulness for regional monitoring authorities

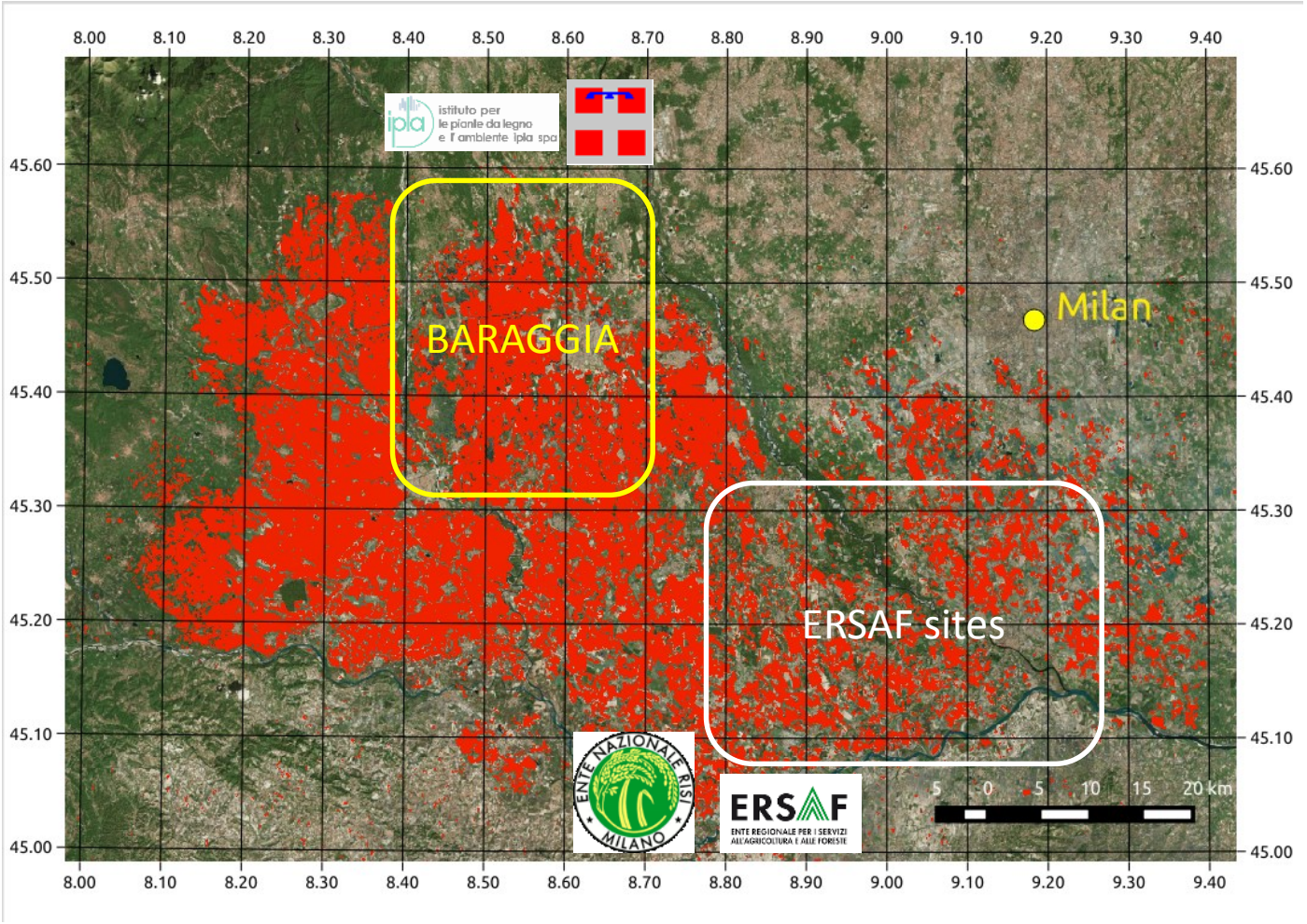
- Get early estimates of rice-invested areas in each year
- Mapping of rice cultivated areas in relation to agro-practices (Dry vs Water sowing);

  - Servizio fitosanitario of Lombardy Region is required to monitor rice cultivations !
  - DIRECTIVE 2009/128/EC of the European Parliament and of the council of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides

    - Limitation to the use of herbicide Oxadiazon in «dry-sowed» rice fields in Lombardy Region, since alternative products can be used.

    - ERMES product allowing monitoring of flooded areas can help in identifying extent and location of dry-sowing areas

STUDY AREAS & FIELD DATA



- **2003-2015**

Statistics on rice variety and agro practices at municipality scale from ENR

- **2015**

In situ monitoring of 40 rice fields to collect observations on rice variety and agro practices by ERSAF

- **2016**

In situ monitoring of water dynamics and flooding occurrence (8 stations) and field surveys at regional scale by IPLA, Regione Piemonte, IREA-CNR

STUDY AREAS & FIELD DATA

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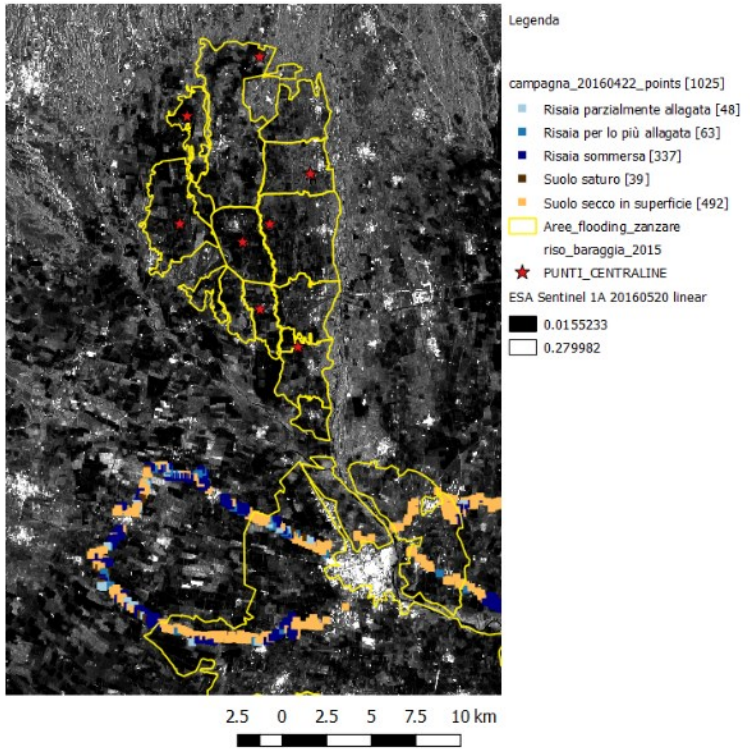
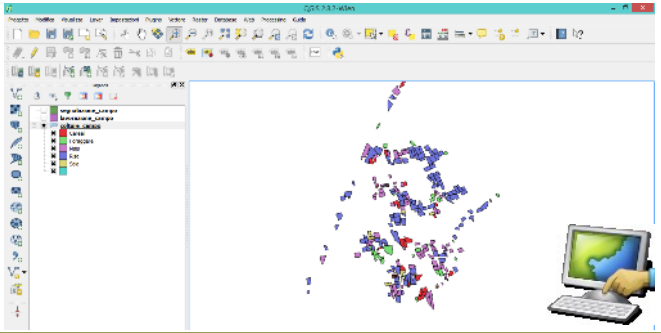
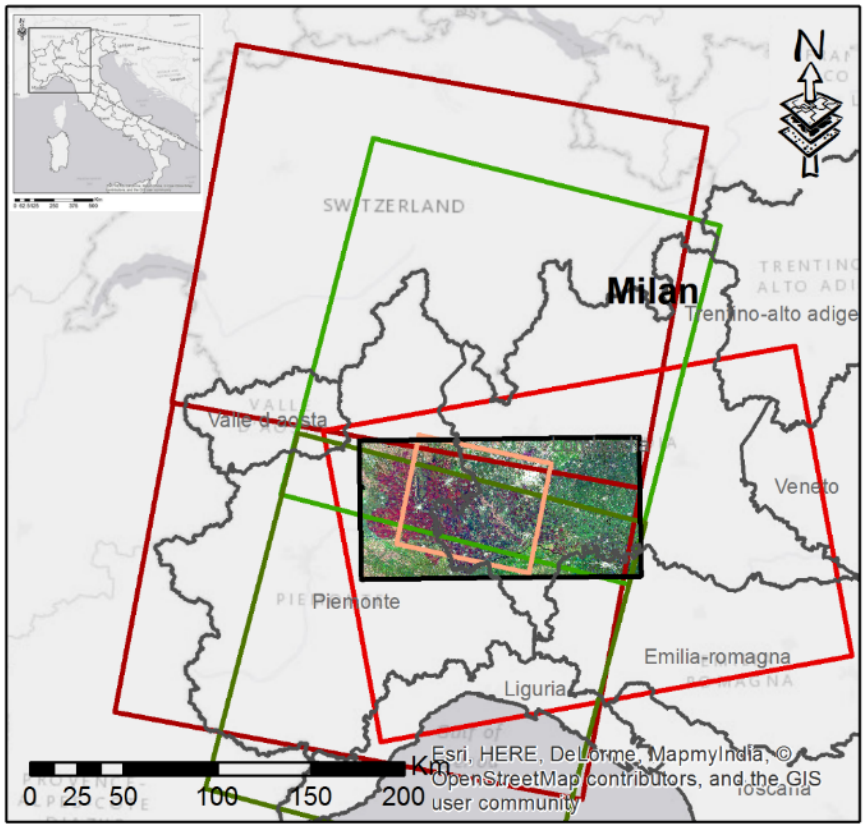


Surface conditions observed and photographed during field survey: saturated soil (a), partially flooded (b), submerged (c) and dry soil (d)

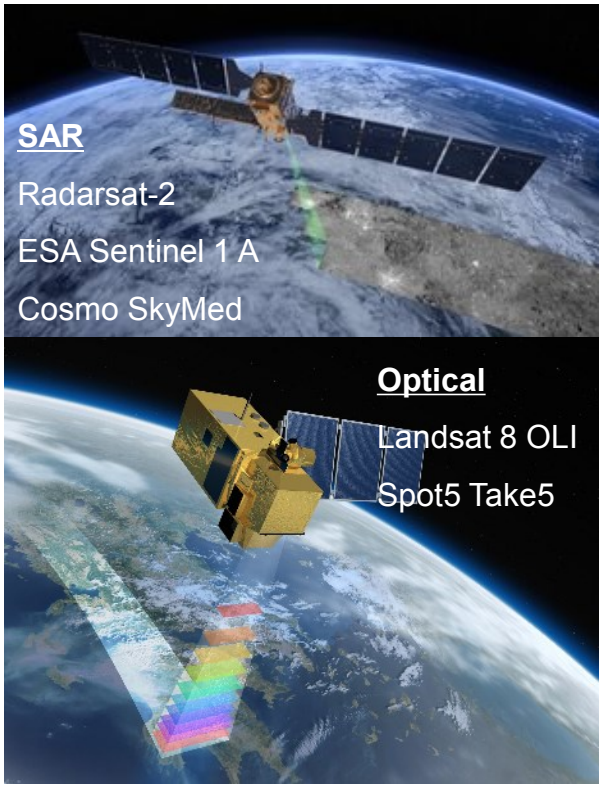


SATELLITE DATA



Region
Study Area
S5T5_frame
OLI P194/R29
OLI P194/R28
S1a asc
S1a desc

Sentinel 1A
RGB
2015/03/23
2015/06/15
2015/08/02



RICE MAPPING

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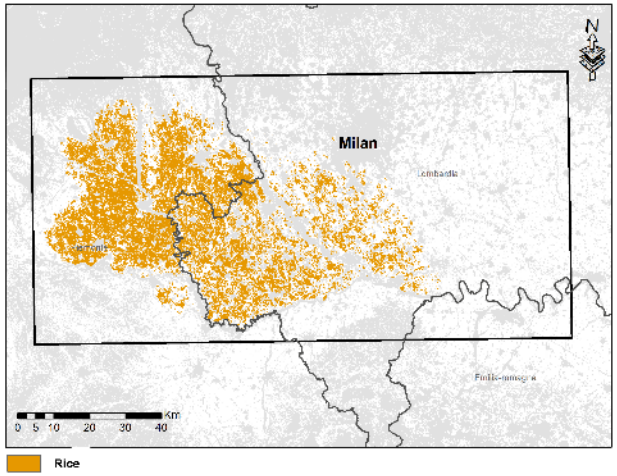
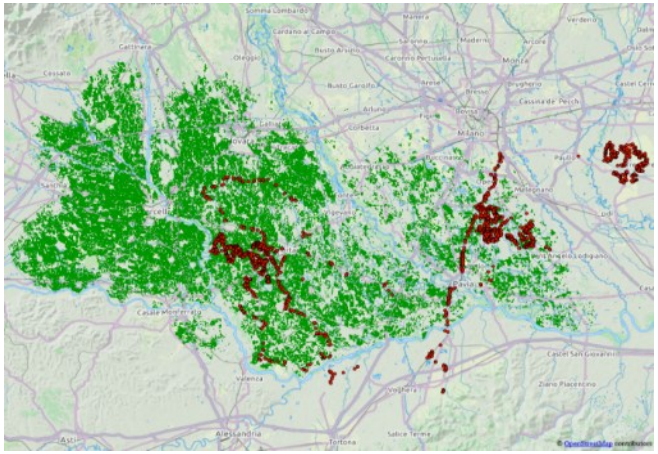
EARLY SEASON

END OF SEASON

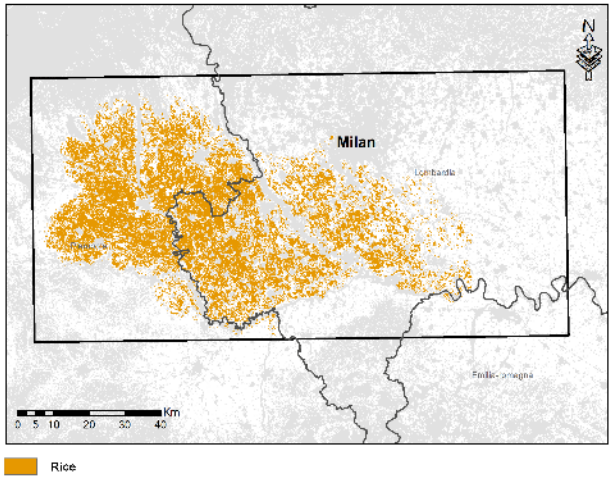
2015

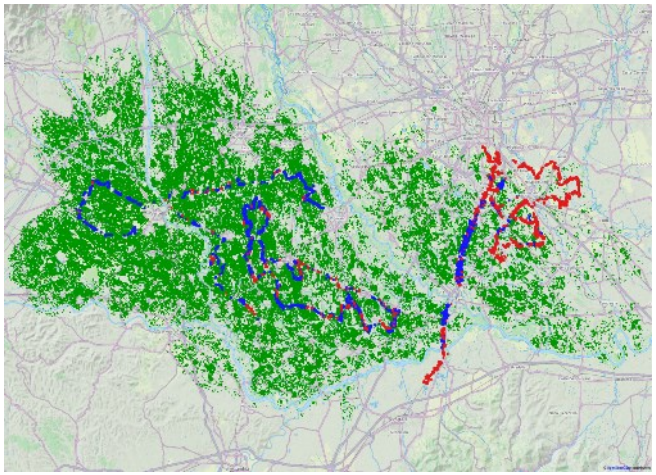




	OA [%]	Kappa
Italy, Early	86.9	0.74
Italy, End of season	91.8	0.86

2016





	OA [%]	Kappa
Italy, Early	88.2	0.76
Italy, End of season	89.1	0.78

RICE MAPPING & AGRO-PRACTICES

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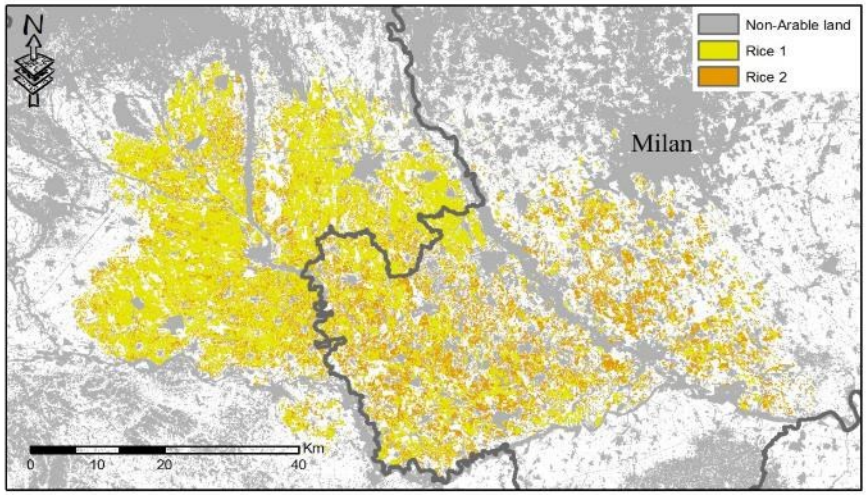
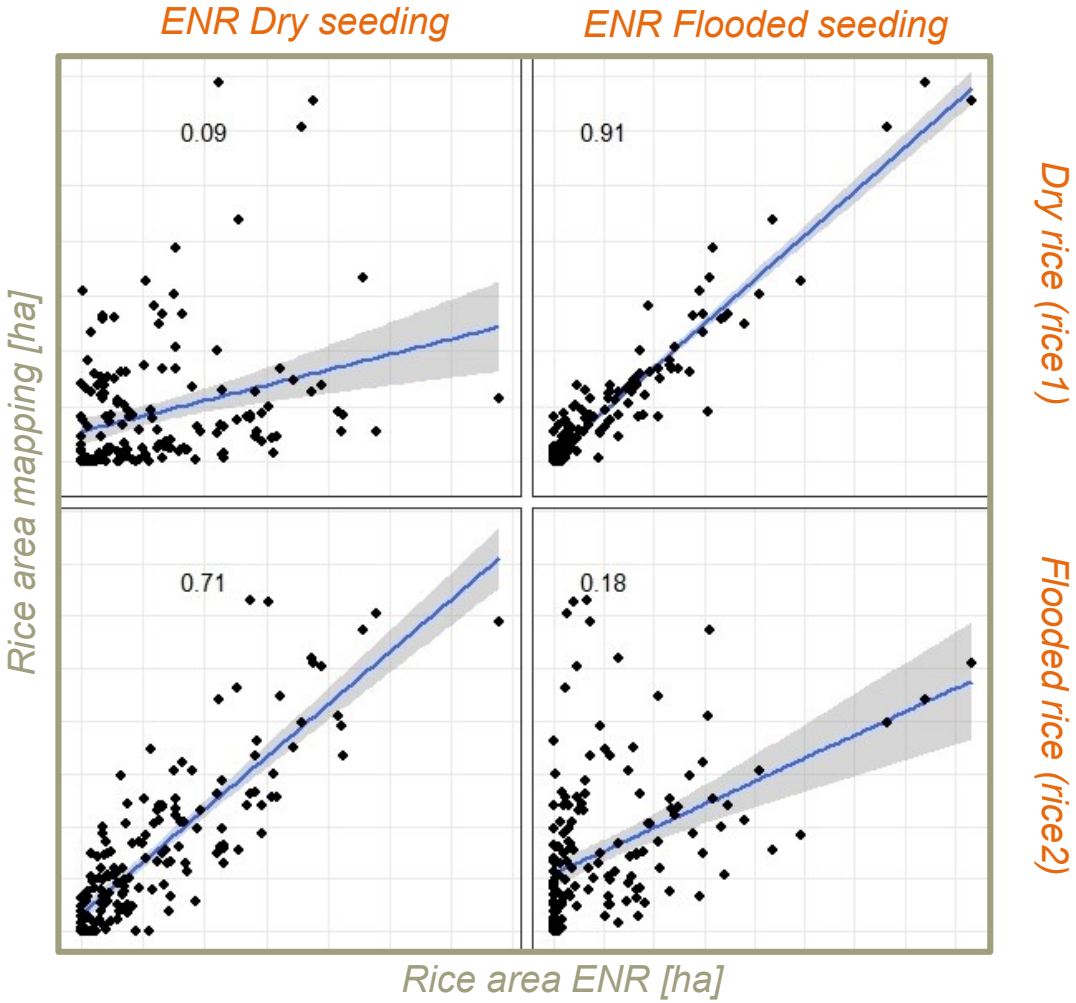
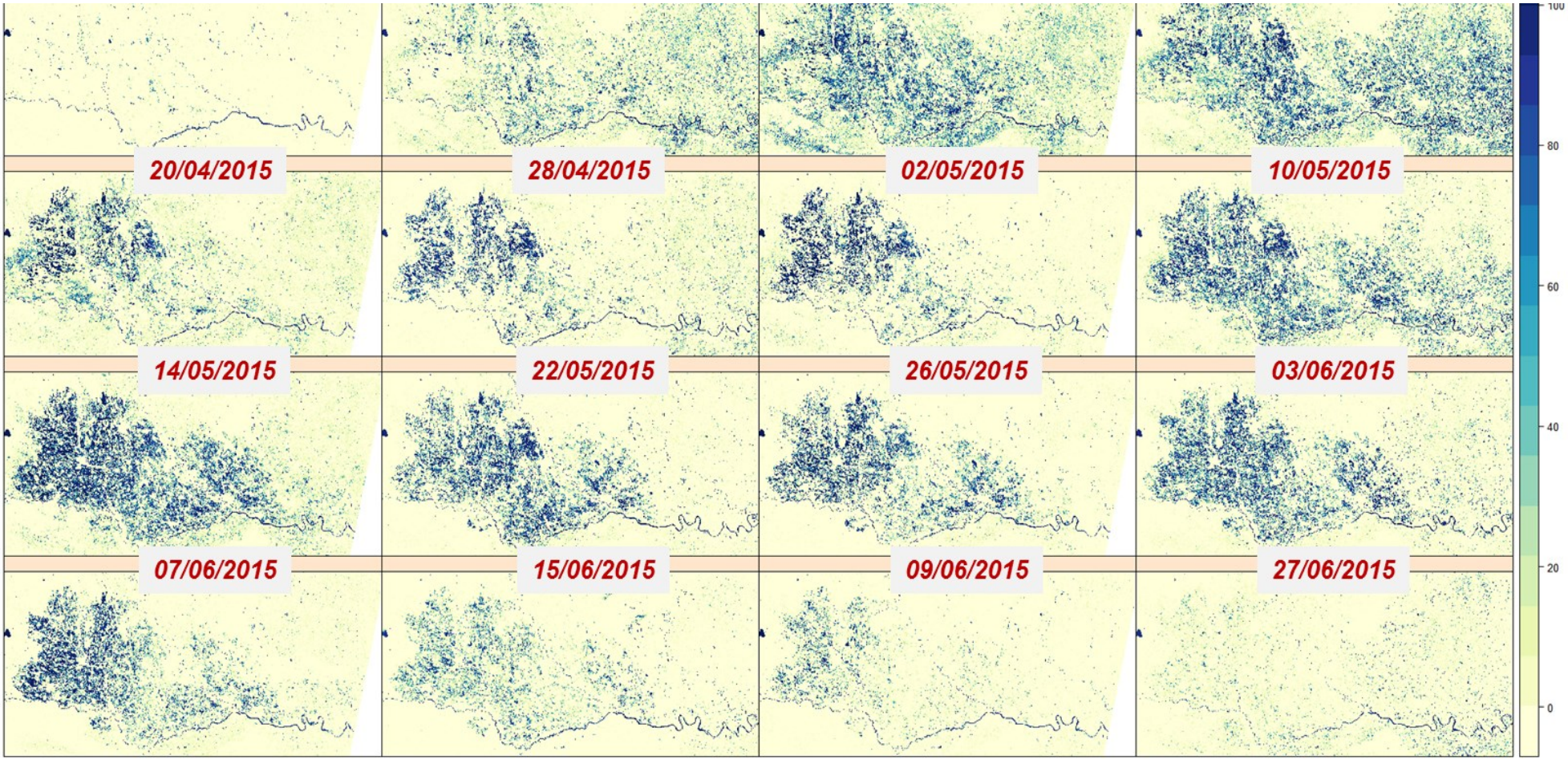
Rice area 2015





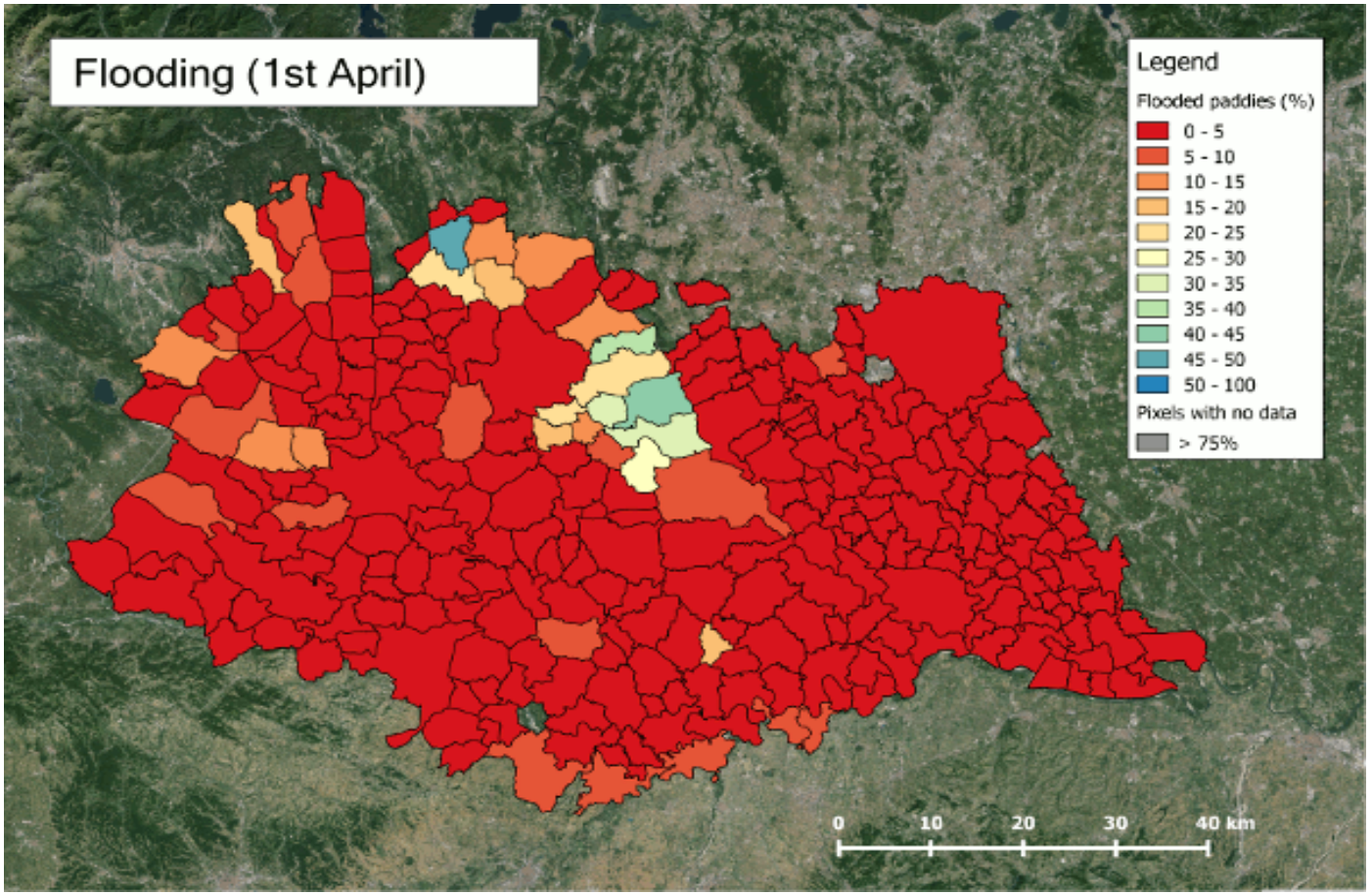
FLOODING MAPPING

Flooding dynamics – 2015



FLOODING MAPPING & AGRO-PRACTICES : MUNICIPALITY SCALE

Flooding frequency – 2015



FLOODING MAPPING & AGRO-PRACTICES: FIELD SCALE 2015

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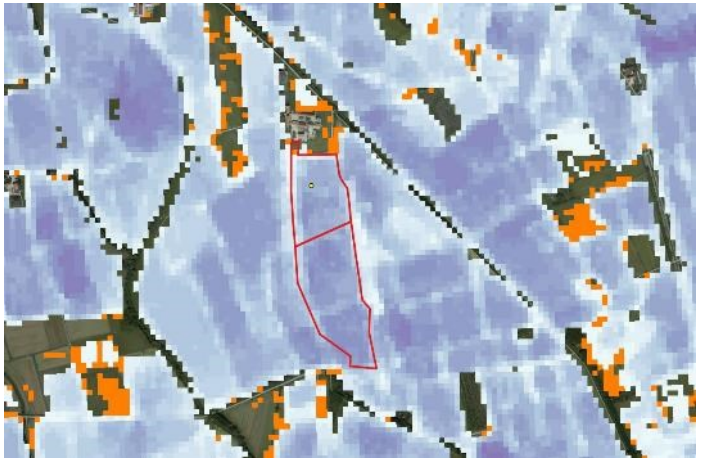
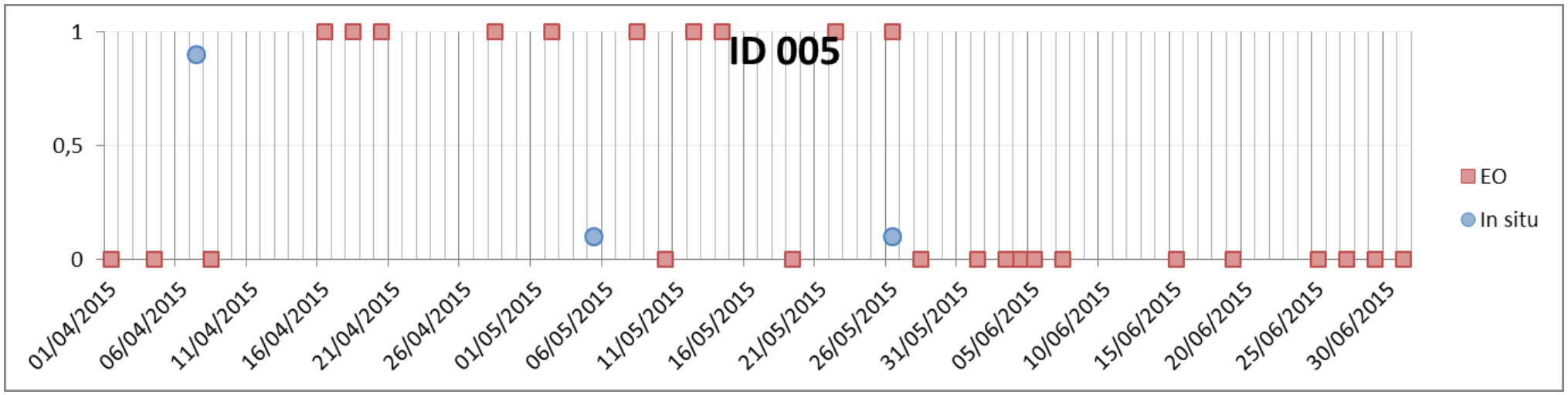
ID_ENR: 005
Name: Az. Agr. Battaglia
Location: Cassolnovo





Flooding occurrence – 2015

FLOODING MAPPING & AGRO-PRACTICES: FIELD SCALE 2015

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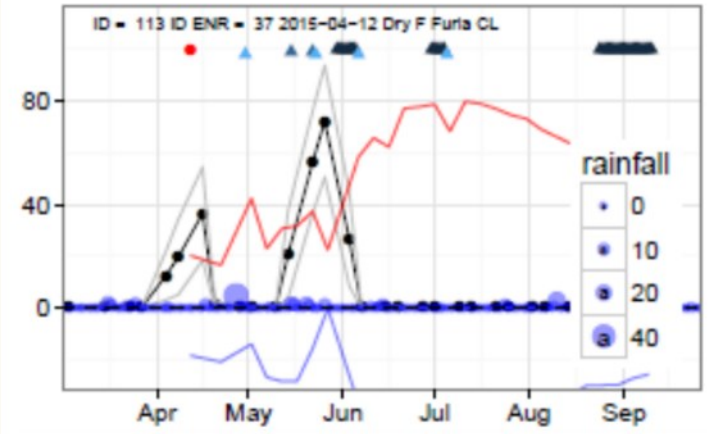
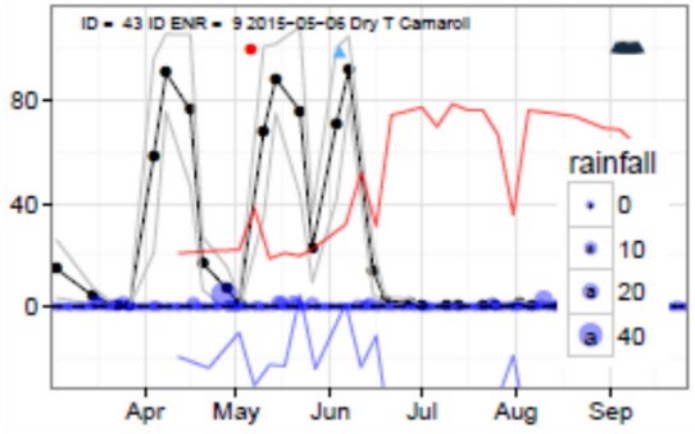
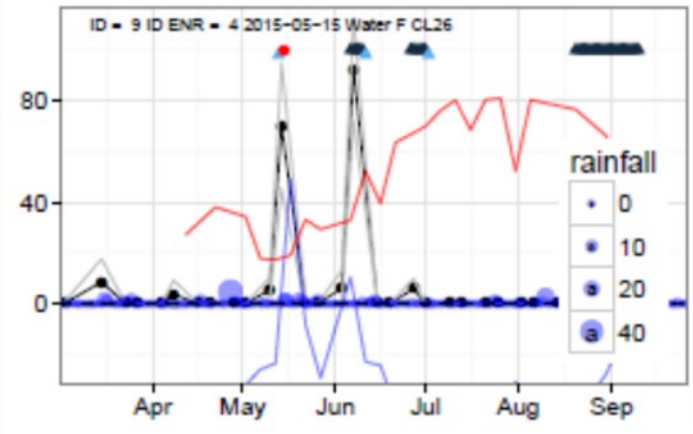
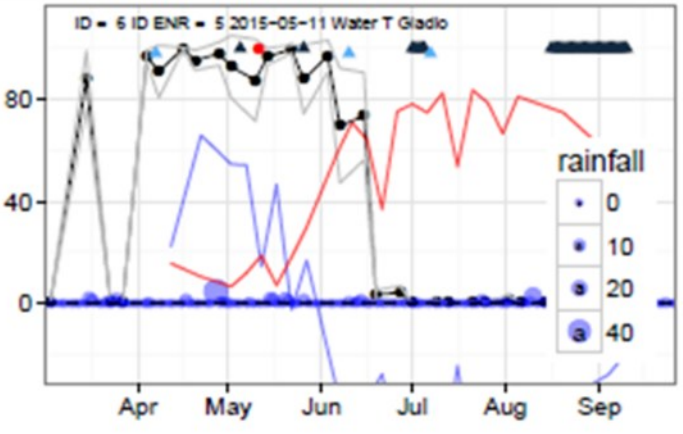
Semina file interrate		
Semina spaglio acqua		

FLOODING MAPPING & AGRO-PRACTICES : REGIONAL SCALE 2016

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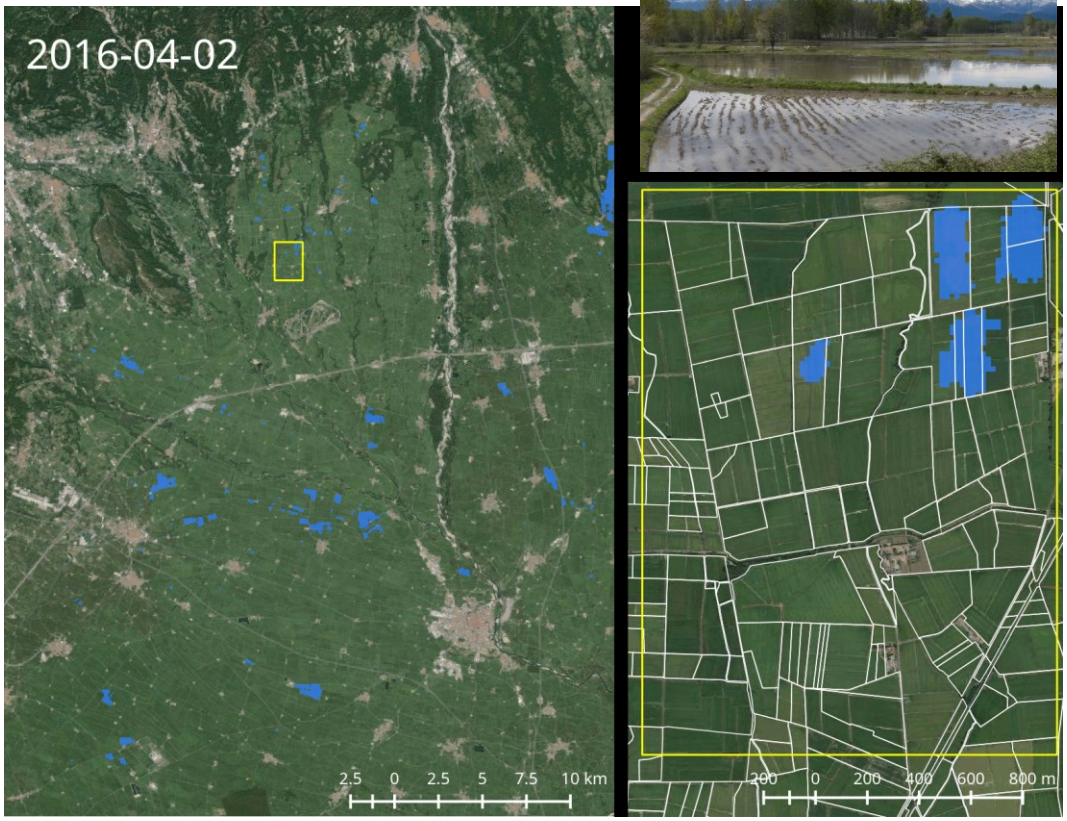
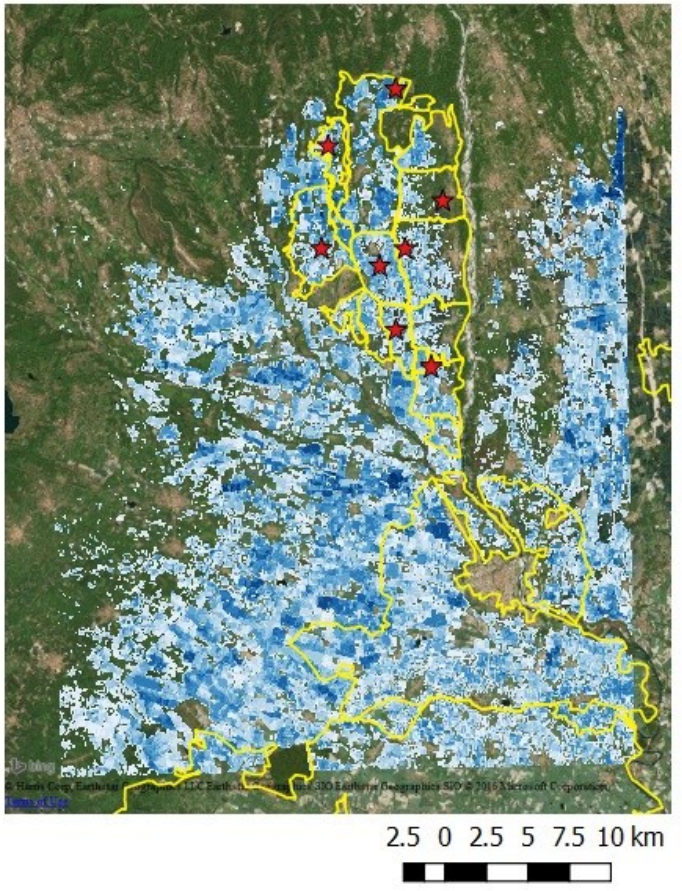
Dynamic information





Static summary information

FLOODING MAPPING VALIDATION 2016

Georeferenced point comparison of flooded/not flooded conditions

Surface conditions	SAR not flooded	SAR flooded
Risaia parzialmente allagata	9	16
Risaia per lo piu allagata	5	24
Risaia sommersa	9	140
Suolo saturo	6	5
Suolo secco in superficie	144	53
Total	173	238

Only simultaneous dates can be used for assessing the accuracy due to the dynamic behavior of water presence

Accuracy by aggregating categories observed in the field

Classificazione del dato satellitare	Riferimento a terra - Non allagato	Riferimento a terra - Allagato	Totale	Accuratezza dell'utilizzatore (%)	Errore di commissione (%)
Dato satellite - Non allagato	150	23	173	87 %	13 %
Dato satellite - Allagato	58	180	238	76 %	24 %
Totale	208	203			
Accuratezza del produttore (%)	72 %	89 %			
Errore di omissione (%)	28 %	11 %			

*Confusion matrix from field surveys carried out on April 22, 2016 (**411 observations**)*

Overall accuracy = 80,3 %
Kappa = 0,61

FLOODING MAPPING VALIDATION 2016

In situ sensors (8 fields)

Classificazione del dato satellitare	Sensore centralina - Allagato	Sensore centralina - Non Allagato	Totale	Accuratezza dell'utilizzatore (%)	Errore di commissione (%)
Dato satellite - Allagato	34	7	41	83 %	17 %
Dato satellite - Non allagato	8	39	47	83%	17%
Totale	43	46			
Accuratezza del produttore (%)	81 %	85%			
Errore di omissione (%)	19 %	15%			

Overall accuracy = 83 %
Kappa = 0.66

*Confusion matrix from in situ sensor measurements over 8 site/field and 11 dates in the period April 2 – June 11 (**88 observations**)*

CONCLUSIONS

❖ Rice mapping

- Accuracy rice mapping >86% also for the in season product (early mapping – mid July)
- Reliable information provided during the on-going season – necessary for managing and forecasting
- Spectral rice properties can provide information on agro-practises; presence/absence of water influences the satellite signal → identification of flooded and dry sowing

❖ Flooding mapping and monitoring

- Flooding mapping accuracy >80%
- In situ sensors allow the detection of short dry periods for rice agro-management
- Issues that can reduce detection accuracy: partially flooded fields and satellite data spatial resolution. That can be solved by post processing GIS analysis
- Comparison with field surveys by regional operators (later than June 2016) provided lower accuracy suggesting that water detection is most accurate at the early stages (no influence of crop plants on the satellite signal)
- Possible to provide information on the use of water and agro-practices also at parcel level

DISCUSSION AND FEEDBACK

ERMES

Near Real Time monitoring of growing season's conditions

❖ Usefulness for regional monitoring authorities

- NRT information on rice development and/or growing conditions can be derived from various sources (satellite, meteo models, etc.). This allows a **constant monitoring of the season**, thus permitting to identify anomalies.
- Reliance on free-of-charge satellite and meteo data allows an inexpensive solution for large-area monitoring, and may allow to better focus in-field monitoring activies (*Note: free of charge meteo data proved sometimes to be not sufficiently accurate – alternative solutions had to be identified*)
- Besides the ERMES «standard» products, additional info and/or info better tailored for dissemination to the general publi can be derived from dedicated geospatial processing of available datasets

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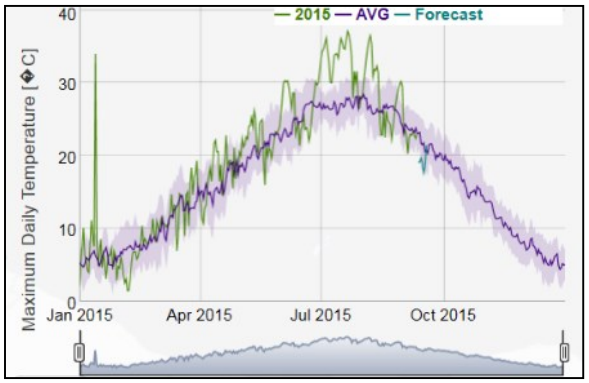
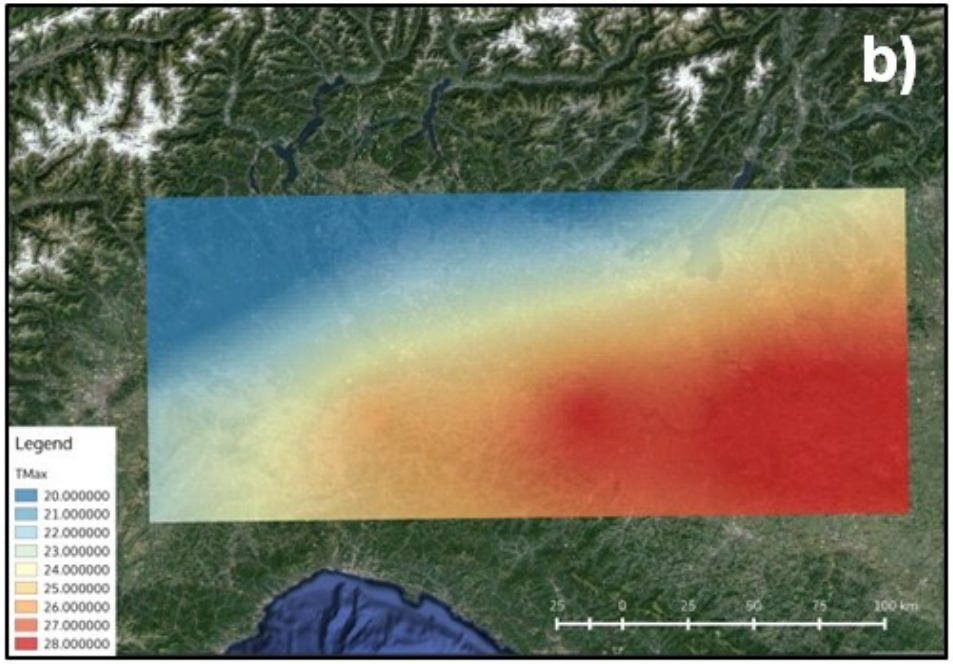
Multitemporal Meteorological maps

- Daily 2x2 km meteo maps produced for several meteo variables for IT, ES, GR, + 6 days of forecast
- Derived from ECMWF TIGGE (GR, ES) and WRF mesoscale model (IT) data. Intercalibrated (when possible) with the MARS dataset of ground observations to achieve reduction of bias.
- Generated in NRT during the rice season – used to monitor meteo conditions with respect to historical data, and as inputs to WARM model



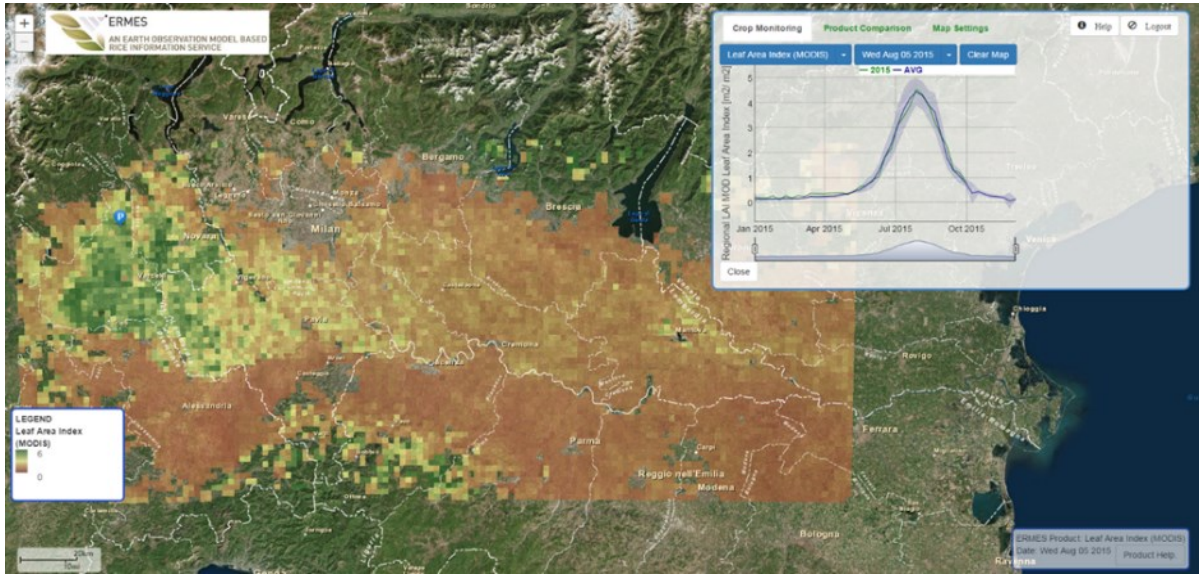
2015 Maximum Temperature time series - IT



Example Daily Meteorological maps in the three countries

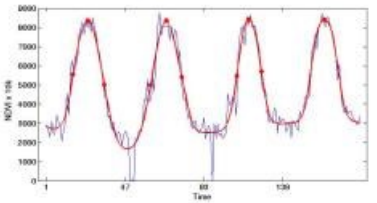
Multitemporal LAI and NDVI maps

- Weekly NDVI maps produced from MODIS 250m data
- 2x2 km LAI Maps produced from Proba-V and MODIS every 10 days for IT, ES, GR → Input to WARM !
- Produced in NRT during the whole season, exploiting automated processing chains
- Strong differences between the current year values for a given date and the average may indicate an anomaly in growth conditions (e.g., anticipated or delayed development due to meteo conditions), or a change in the kind of crop cultivated in the area.

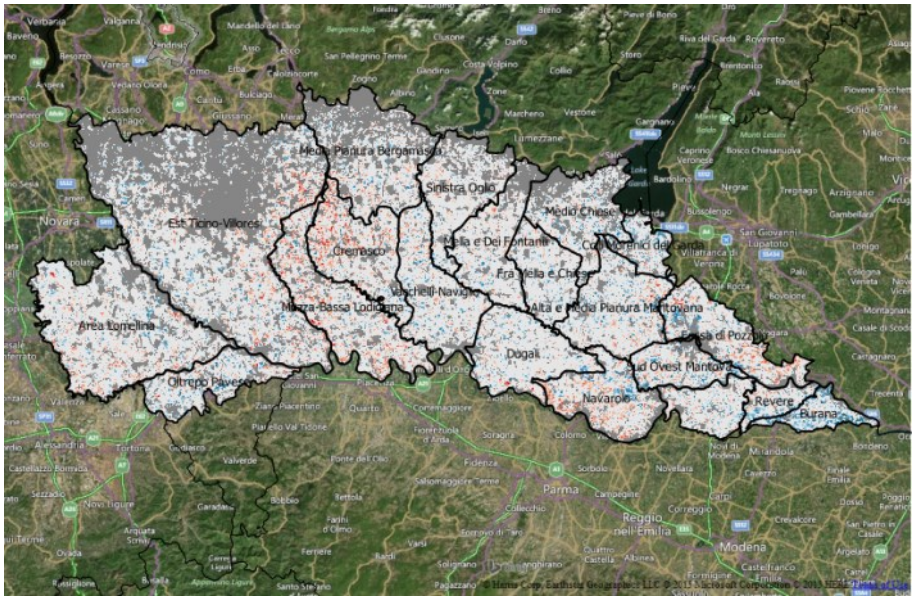


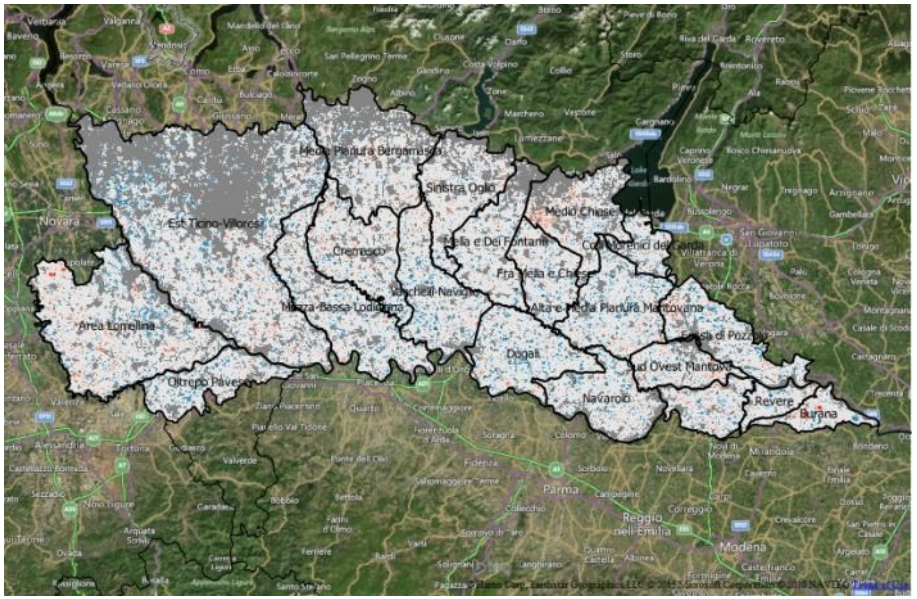
LAI maps for the Italian study area for the date 05/08/2015, derived from MODIS data and their temporal profiles for 2015

- **Anomaly in crop development from time series analysis (2003-2015)**



2014 14 Sep 2015





Z-Score

Below Normal Above

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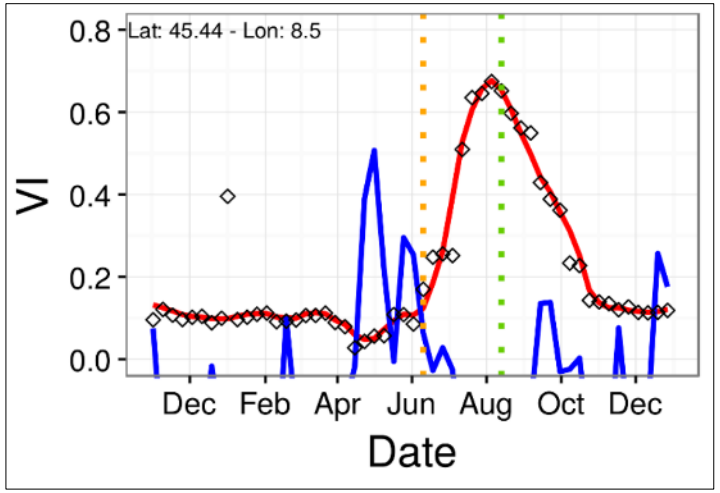
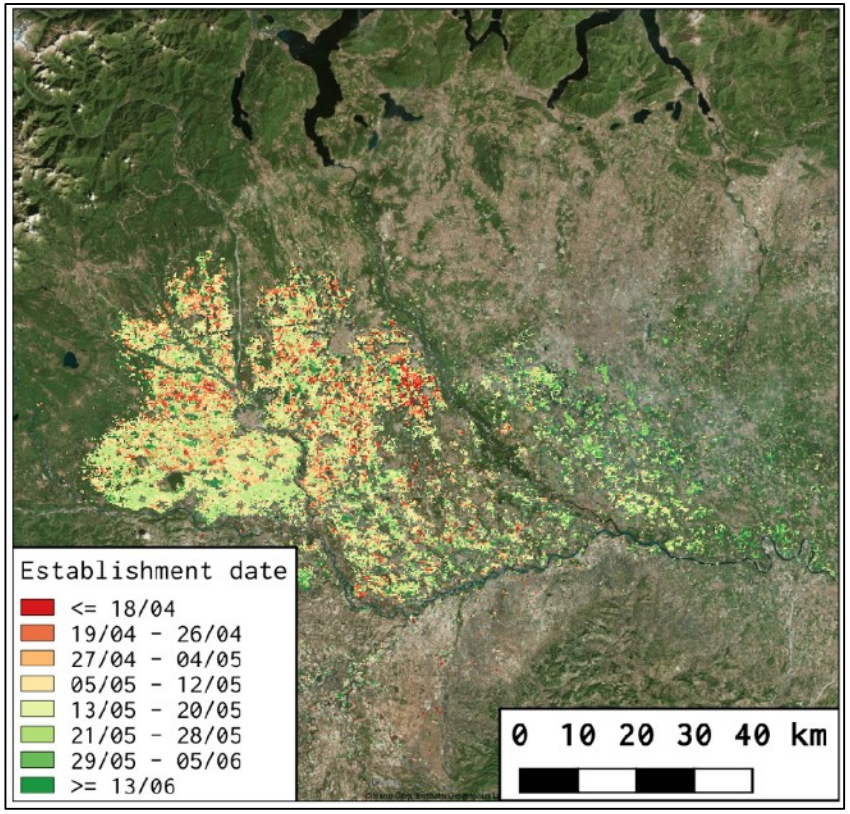
Phenological Maps

- 250m resolution phenological maps for the three study areas ,produced starting from time series of MOD13Q1 and MYD13Q1 data (PhenoRice algorithm)





Phenological Maps

- 250m resolution phenological maps for the three study areas ,produced starting from time series of MOD13Q1 and MYD13Q1 data (PhenoRice algorithm)
- Aggregated on 2x2 km grid cells to get average estimated sowing dates
- Different maps created at monthly time steps, exploiting MODIS imagery available up to the moment of product creation → allowing to have an estimate of sowing dates around end of Juned

Country	Parameter	Average	Standard Deviation (days)
Italy	Sowing Date	11 May	11.1
	Emergence Date	30 May	9.4
	Heading/Flowering Date	29 July	9.2
Spain	Sowing Date	16 May	4.1
	Emergence Date	07 June	2.8
	Heading/Flowering Date	03 August	5.0
Greece	Sowing Date	14 May	2.8
	Emergence Date	03 June	2.1
	Heading/Flowering Date	05 August	5.6

Recap of 2016 generated products

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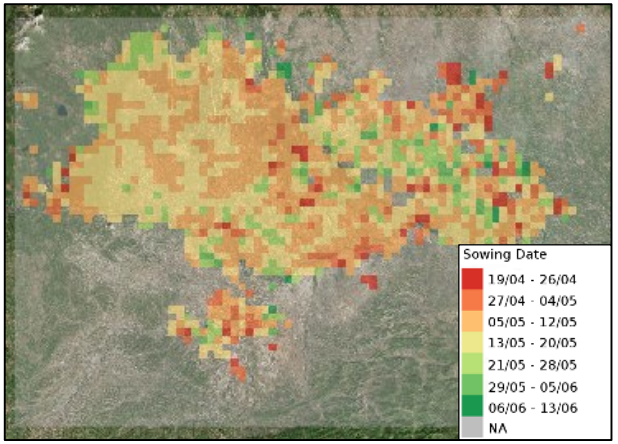
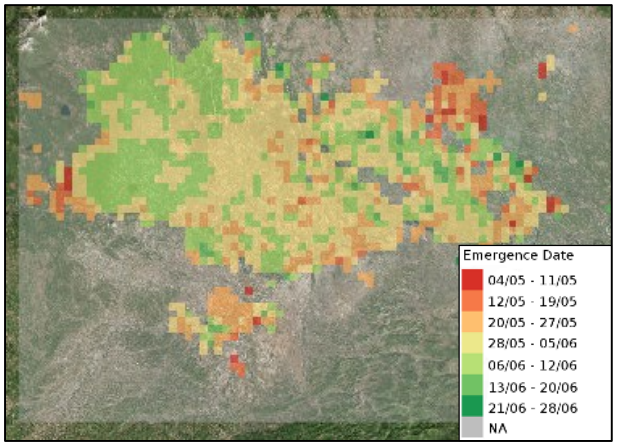
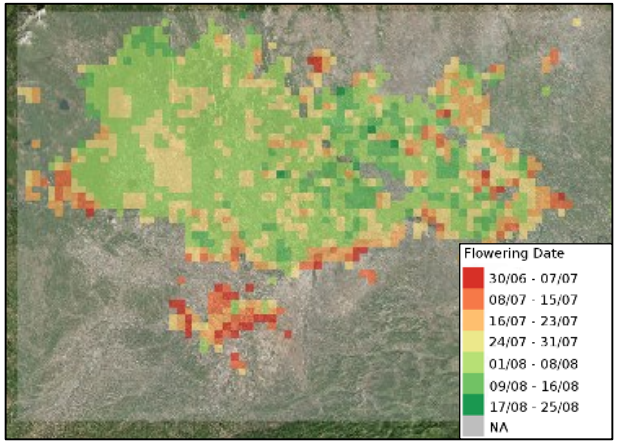
Phenological Maps







Phenological Maps 2016 - Italy

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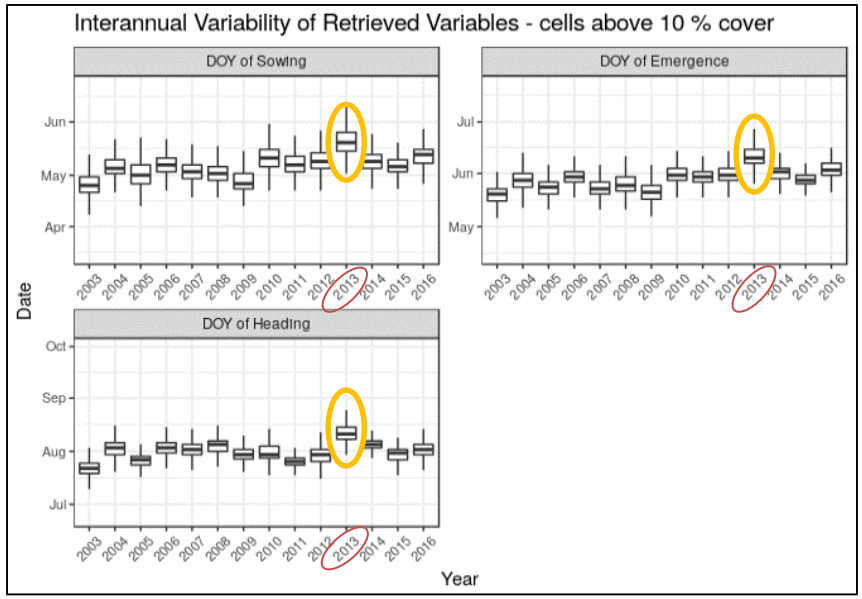
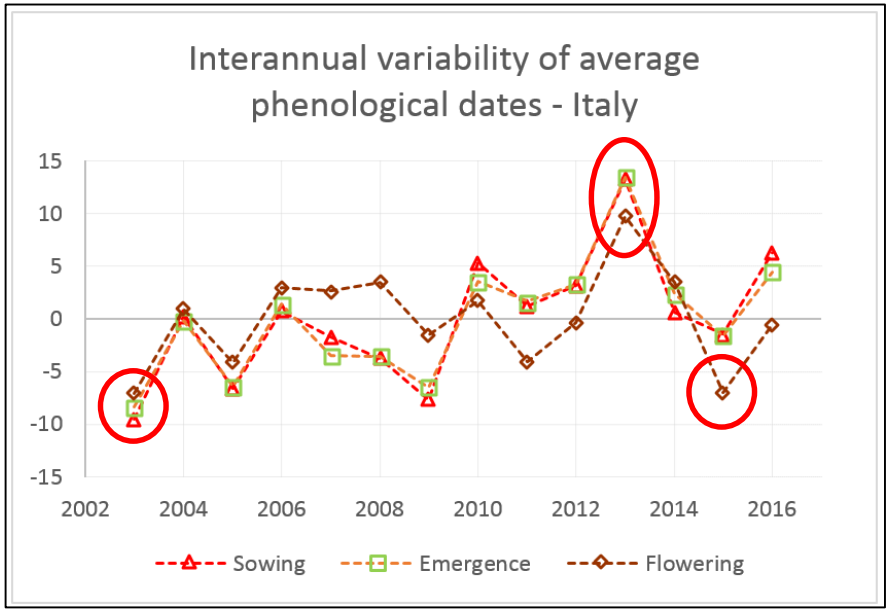
Phenological Maps – analysis

- NRT Phenological maps allow to properly initialize rice crop modelling. Validation highlighted very good results (No BIAS, Average Absolut error atround one week) on «water-sown» fields, but problems in the case of dry-seeding.
- Multiannual analysis allow to detect anomalous years.





Interannual variability of estimated phenological dates

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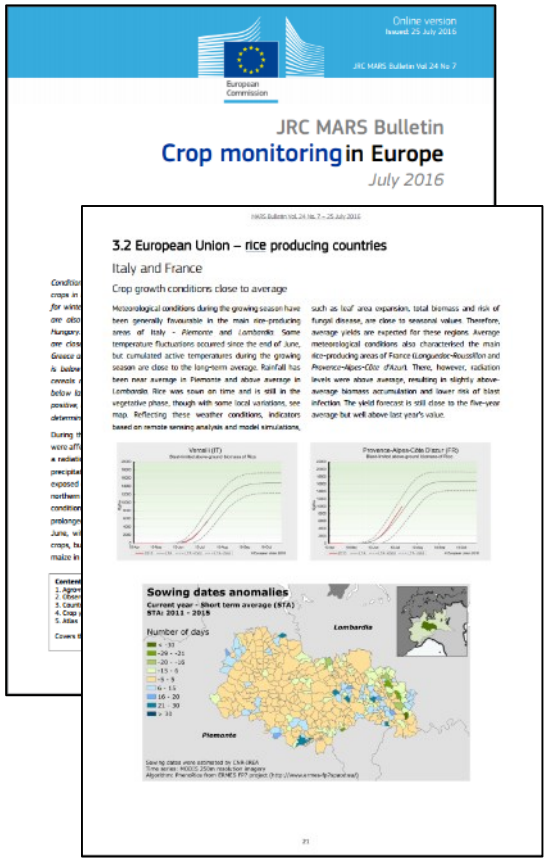
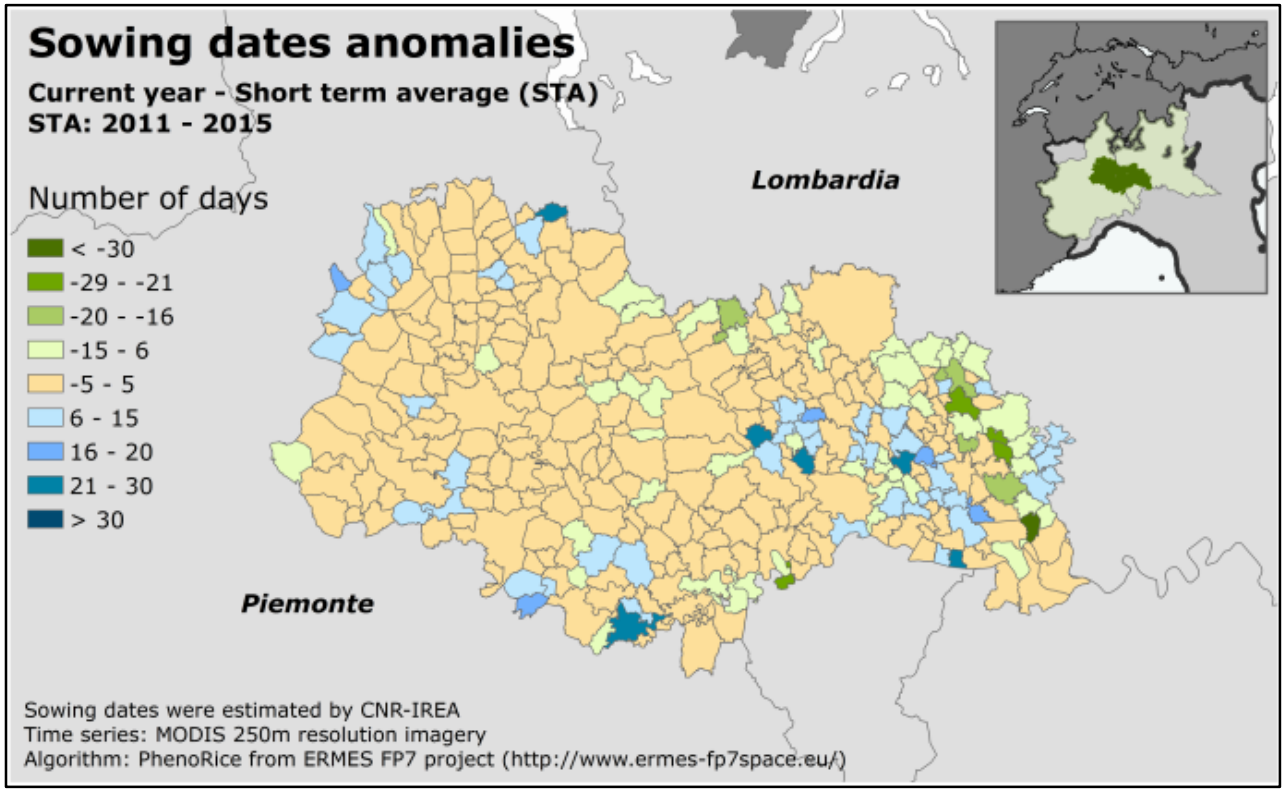
Phenological Maps

- Results can be aggregated at lower scales, to depict the general behaviour of a specific season and area

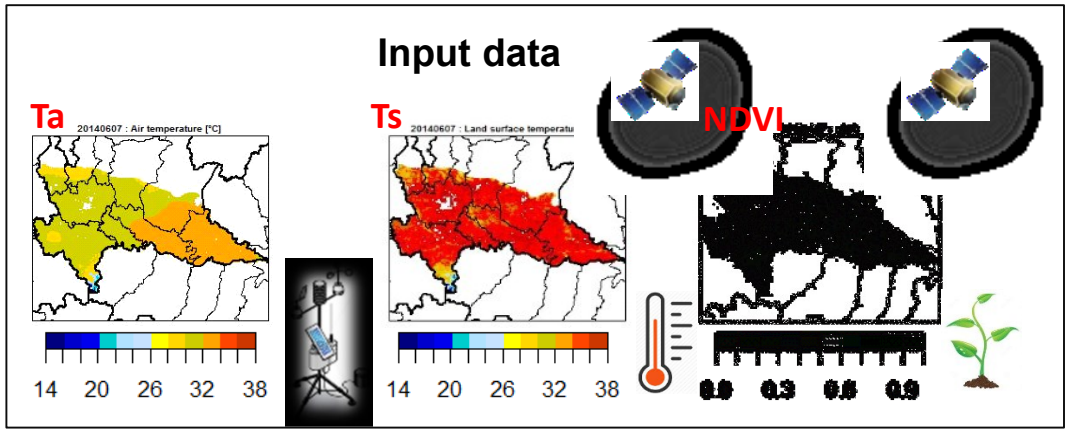


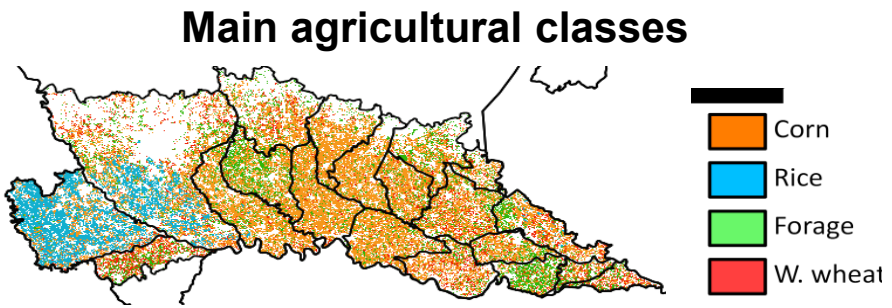


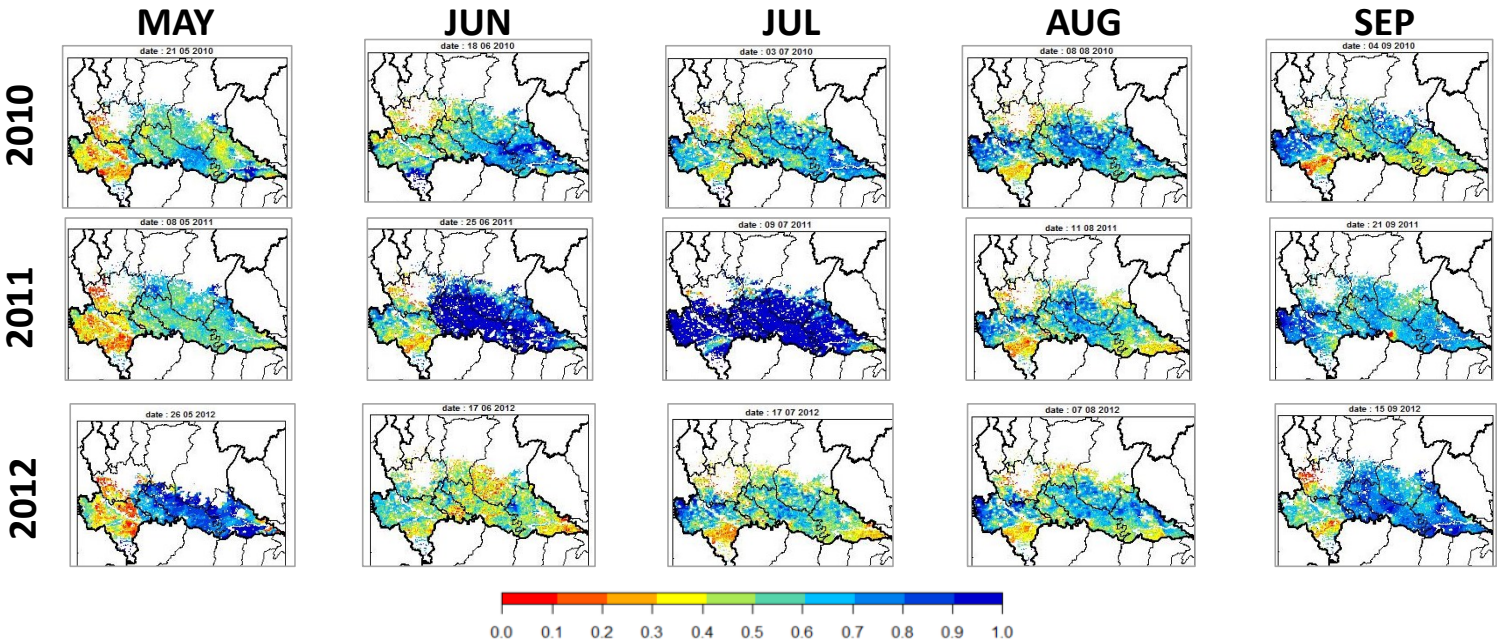
2016 sowing dates anomalies – aggregation on municipalities

EVAPORATIVE FRACTION: INDICATOR OF SURFACE MOISTURE USEFUL TO MONITOR CROP CONDITIONS

Request of: RegioneLombardia Agricoltura







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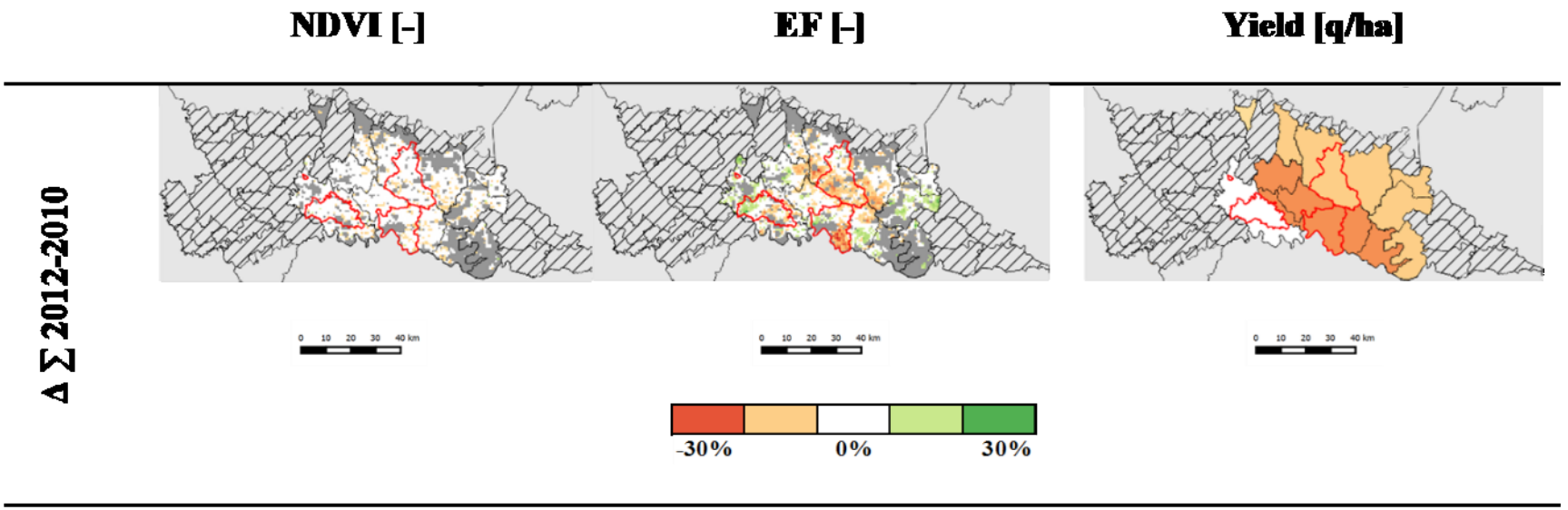
EF usefulness for operational monitoring of crop conditions

- **2012 vs. 2010 difference of weekly NDVI, EF cumulated from June to August and maize yield**
  - Only corn agronomical districts are showed
  - EF shows areas with a significant difference (**up to -30%**) in EF, confirmed by the corn yield difference maps
  - No clear difference is appreciable in the NDVI map



NRT analysis of EF from satellite data can be used as an Early Warning tool for highlighting water-stress conditions

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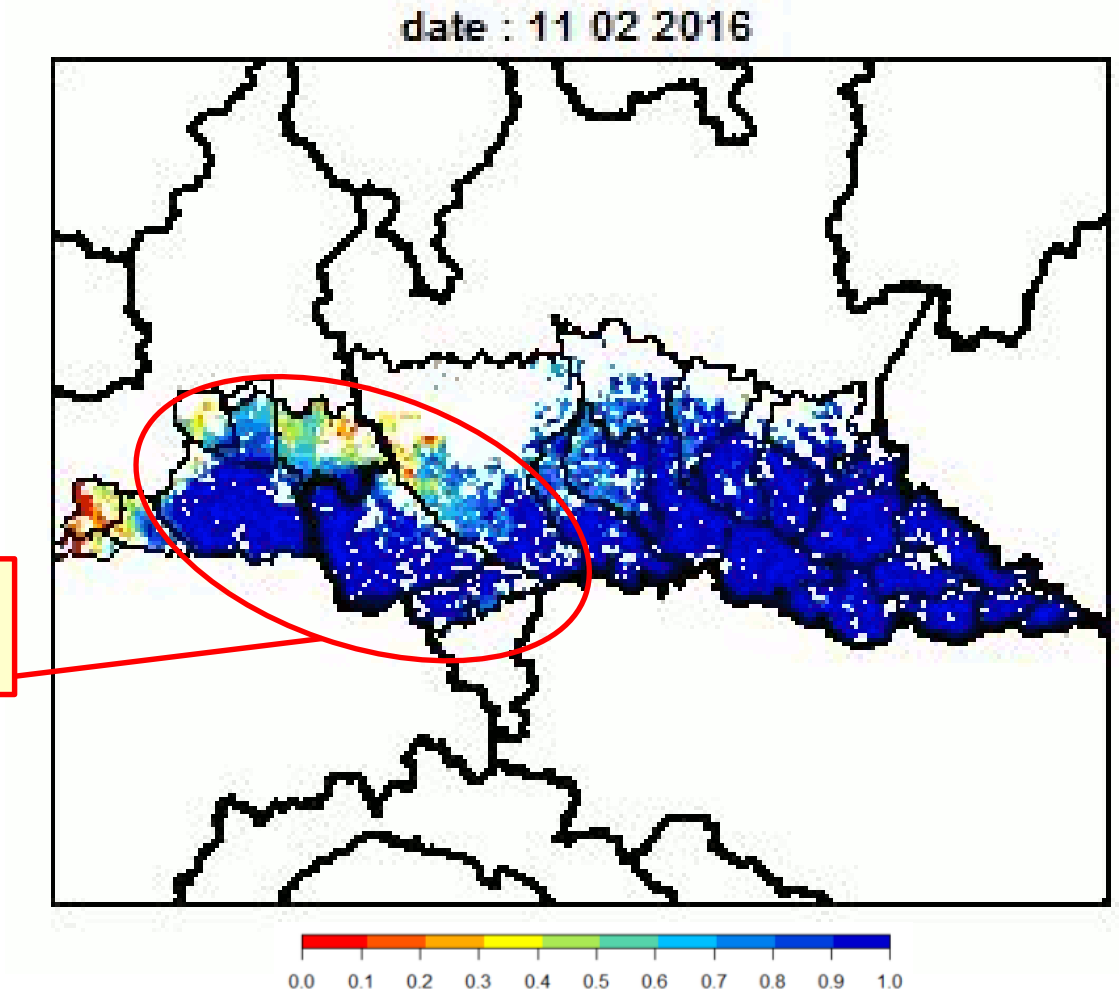
Test for EF estimation in Piedmont



Main Italian rice district

- **The rice district** shows consistently high values of EF starting from beginning of June
- Indeed rice does not face water stress because it is traditionally grown in flooded conditions
- Usefulness of EF maps greater for other crops and areas (e.g., corn)

DISCUSSION AND FEEDBACK

Thanks for your attention !