ROBUST SATELLITE TECHNIQUES FOR MONITORING THE VINEYARDS OF BASILICATA (ITALY)

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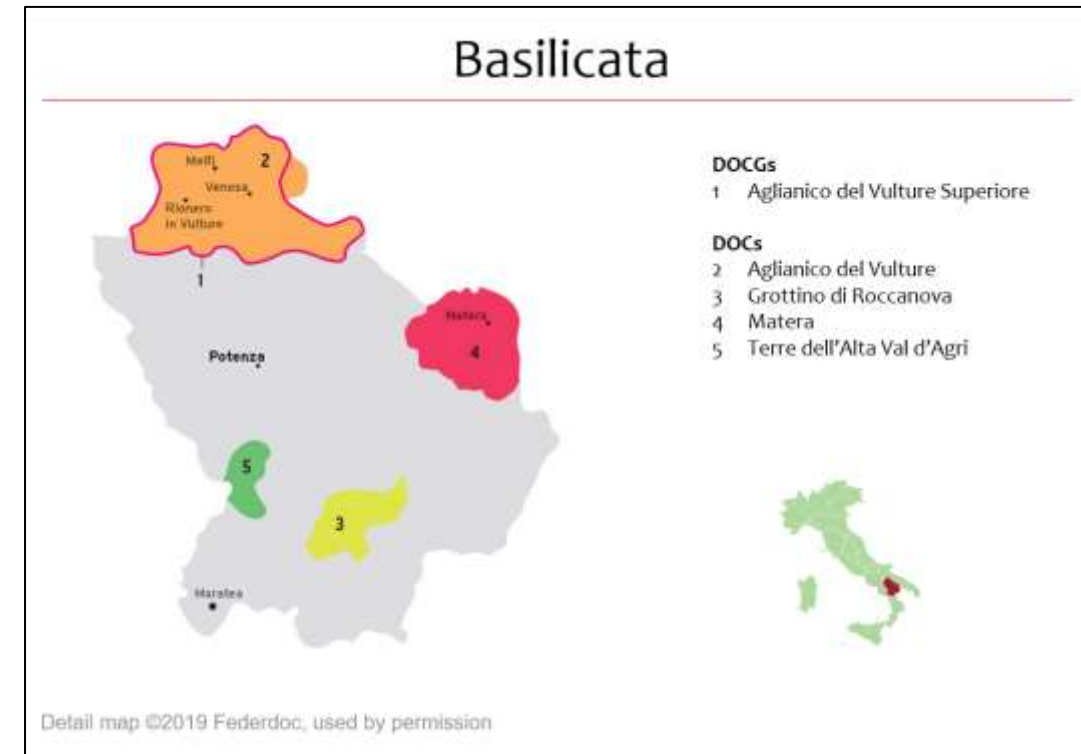
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3) Institute of Methodologies for Environmental Analysis, National Research Council, Tito Scalo (PZ), Italy

The Basilicata wine sector

- About 4,021 ha of vineyard surfaces
  - 2.879 in Potenza province
  - 1.142 in Matera province

- About 4.974 farms
  - 74% in Potenza province
    - IGT vineyards located in mountainous and hilly areas
    - DOC/DOCG vineyards located in hilly areas
  - 26% in Matera Province
    - mainly located in hilly and flat areas

- The region's primary grape variety is Aglianico del Vulture (56%)

Basilicata

DOCGs
1 Aglianico del Vulture Superiore

DOCs
2 Aglianico del Vulture
3 Grottino di Roccanova
4 Matera
5 Terre dell'Alta Val d'Agri

Detail map ©2019 Federdoc, used by permission

Learning from the past

Even out from extremes harvest quality and quantity strongly depends on local conditions
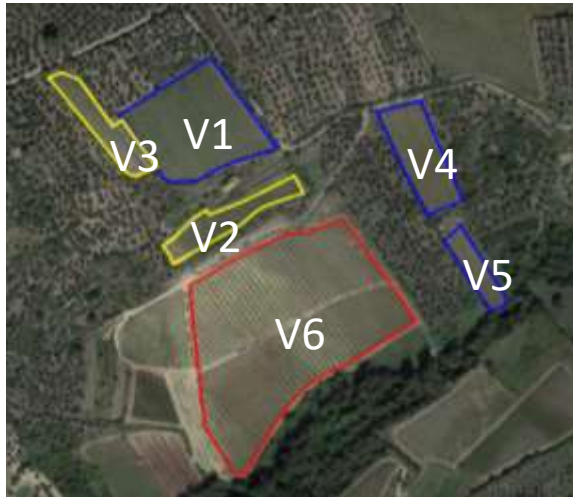
NDVI time-series are used for the reconstruction of the vineyard phenological cycle

- > 500 Sentinel 2/MSI images acquired over Basilicata Region (Southern Italy) in the period 2015-2022:
  - Harmonized Sentinel-2 MSI Level-1C orthorectified top-of-atmosphere reflectance to compute NDVI,
  - Sentinel-2: Cloud Probability to identify clear sky locations.
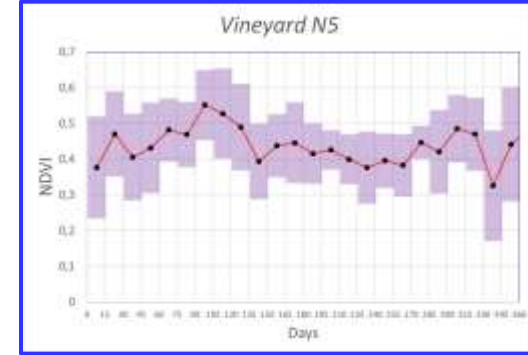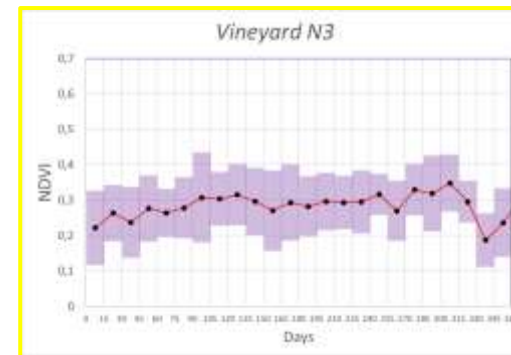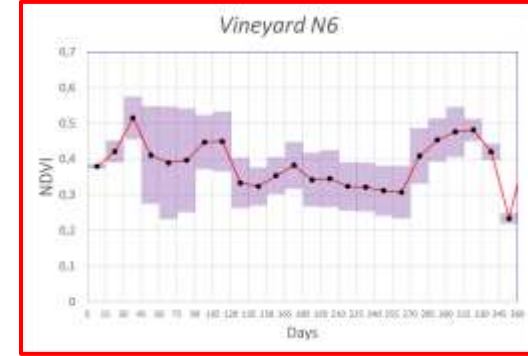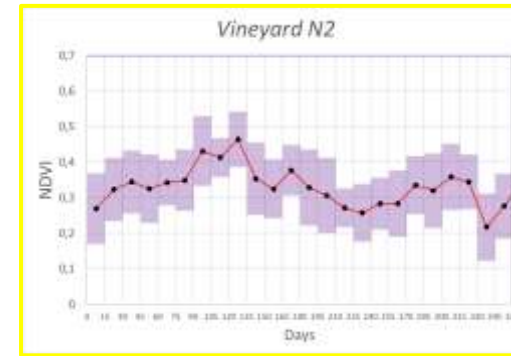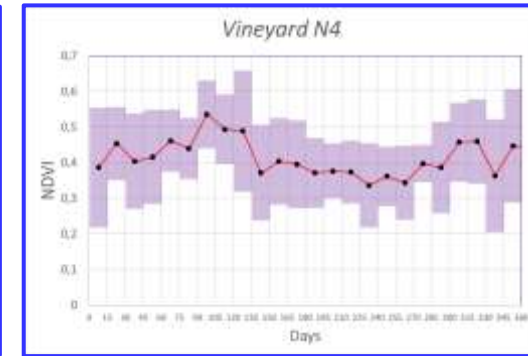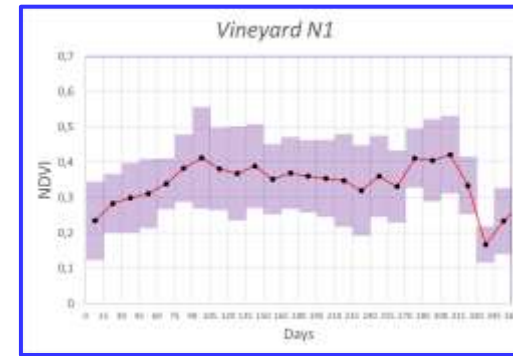
Vineyards phenology

(NDVI spatio/temporally averaged Sentinel2 2015-2022)

How to early detect significant changes ?
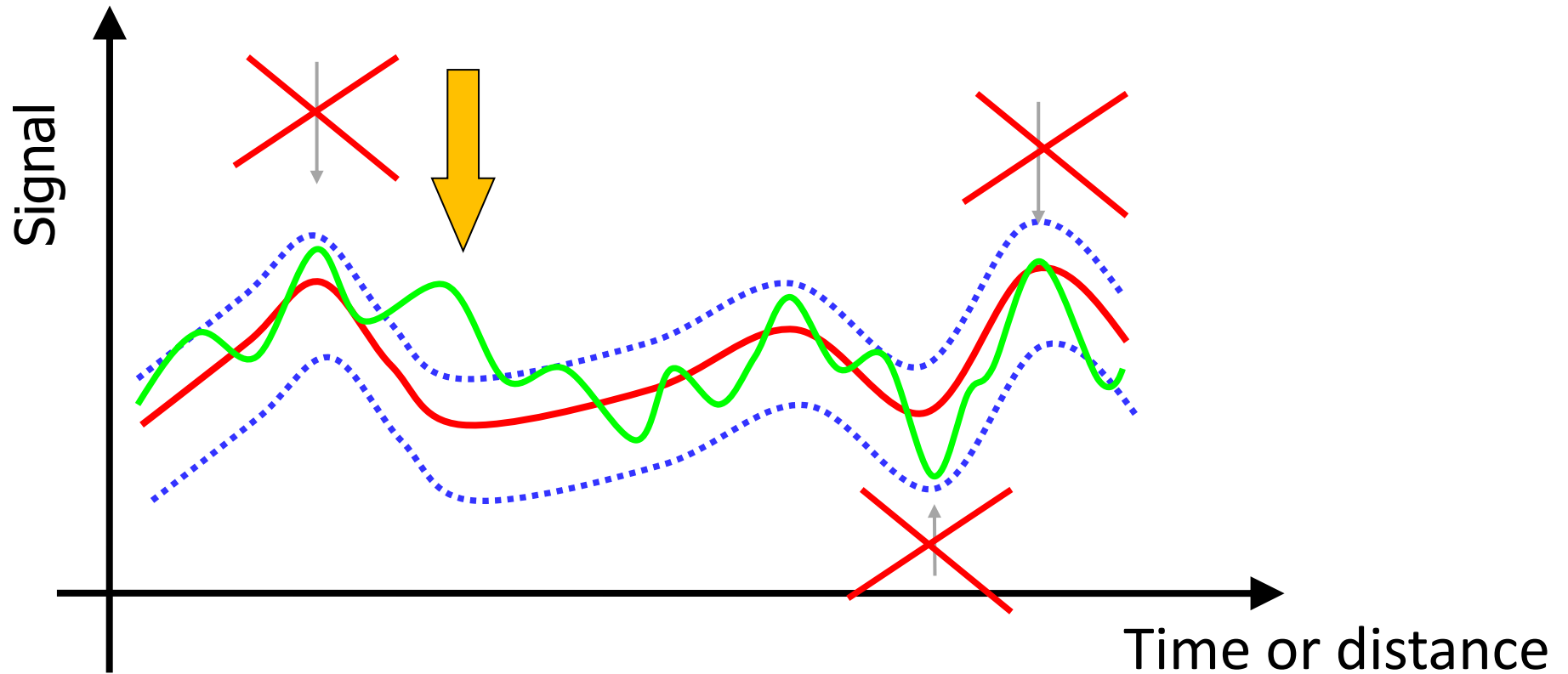
For each pixel x_i, y_i

$$\frac{V(x_i, y_i, t) - V_{ref}(x_i, y_i)}{\sigma(x_i, y_i)}$$

Reduction of: ⟹

- "Site" effects
- Seasonal effects
- "False Alarms"

RST (Robust Satellite Techniques)

(formerly RAT: Robust AVHRR Techniques; V. Tramutoli, 1998, 2005, 2007)

- **Computing the unperturbed reference fields for V(r,t) on a multi-temporal long-term**
HOMOGENEOUS (same time of the day, months of the year, etc.) historical satellite records

$V_{REF}(\mathbf{r})$ and $\sigma_V(\mathbf{r})$

Febr, 1-3 GMT   Febr 1-3 GMT
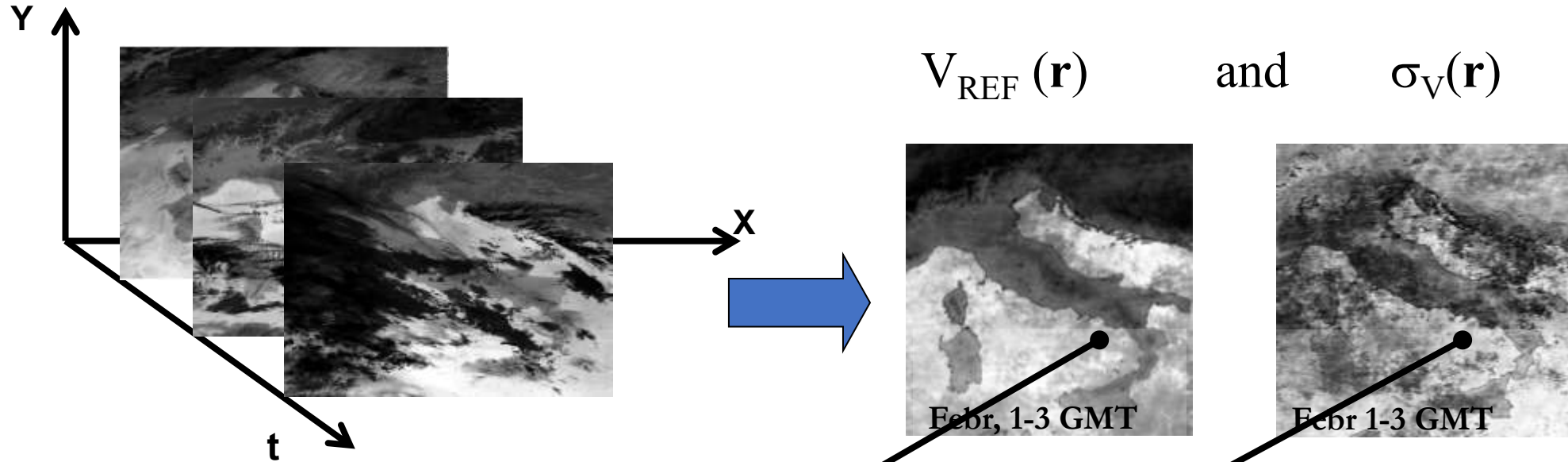
- **Change detection at the time t by:**

$$\otimes_V (x,y,t) = \frac{V(x,y,t) - V_{REF}(x,y)}{\sigma_V(x,y)}$$

A.L.I.C.E.
(Absolutely Llocal Index of Change of the Environment)

Fri 21 July, 2023

20 years of RST Applications
(A general approach for different applications)

Forest fires

e.g. Fires in Italy, February 2005

Voltri

Erli

Casanova Lerrone

Carpasio

🟥 fires

Volcanic Eruptions
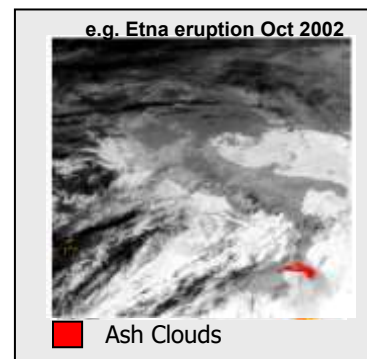
e.g. Etna eruption Oct 2002

🟥 Ash Clouds

Floods

e.g. Basilicata flood, March 2011

🟥 Flooded areas

Dust storms

e.g.Libia 13 May 2004

🟨 Dust clouds

Oil spills

e.g. Oil spill in the Mexico Gulf, April 2010

Deepwater Horizon Location

25.04.2010 171500

🟥 Oil spill

Soil wetnesss

e.g. Carpathian Basin, April 2000

🟧 Raining Clouds
🟦 Weakly wet
🟦 Moderately wet
🟦 Extremely wet

Earthquakes

e.g. 7 September 1999 Athens Earthquake

3 days before EQ

🟥 Thermal anomalies

Infrastructures
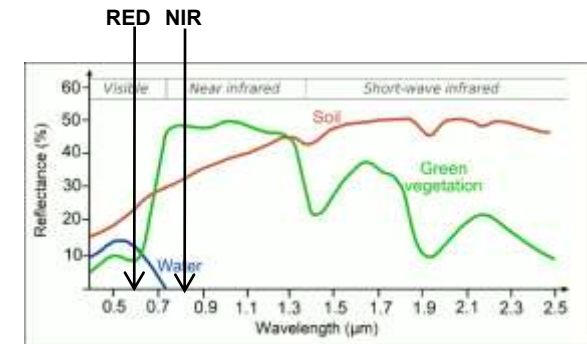
e.g. 18 October 2005 IRAQ
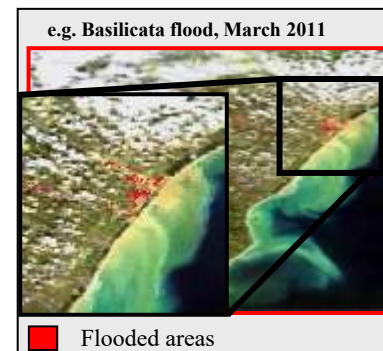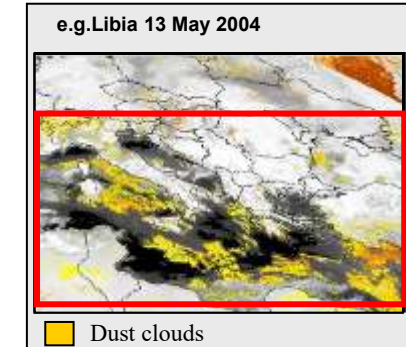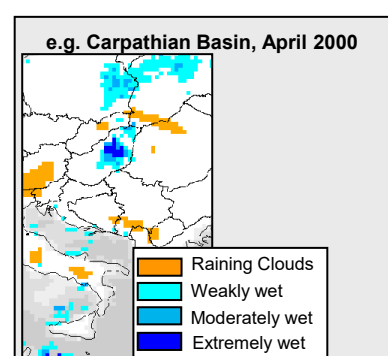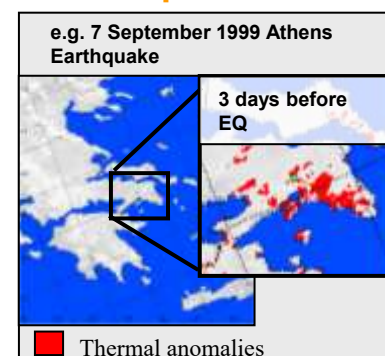
🟥 Explosions
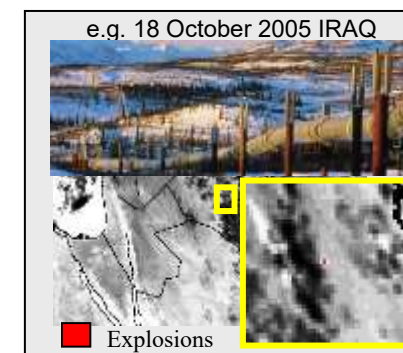
RST for vineyard monitoring
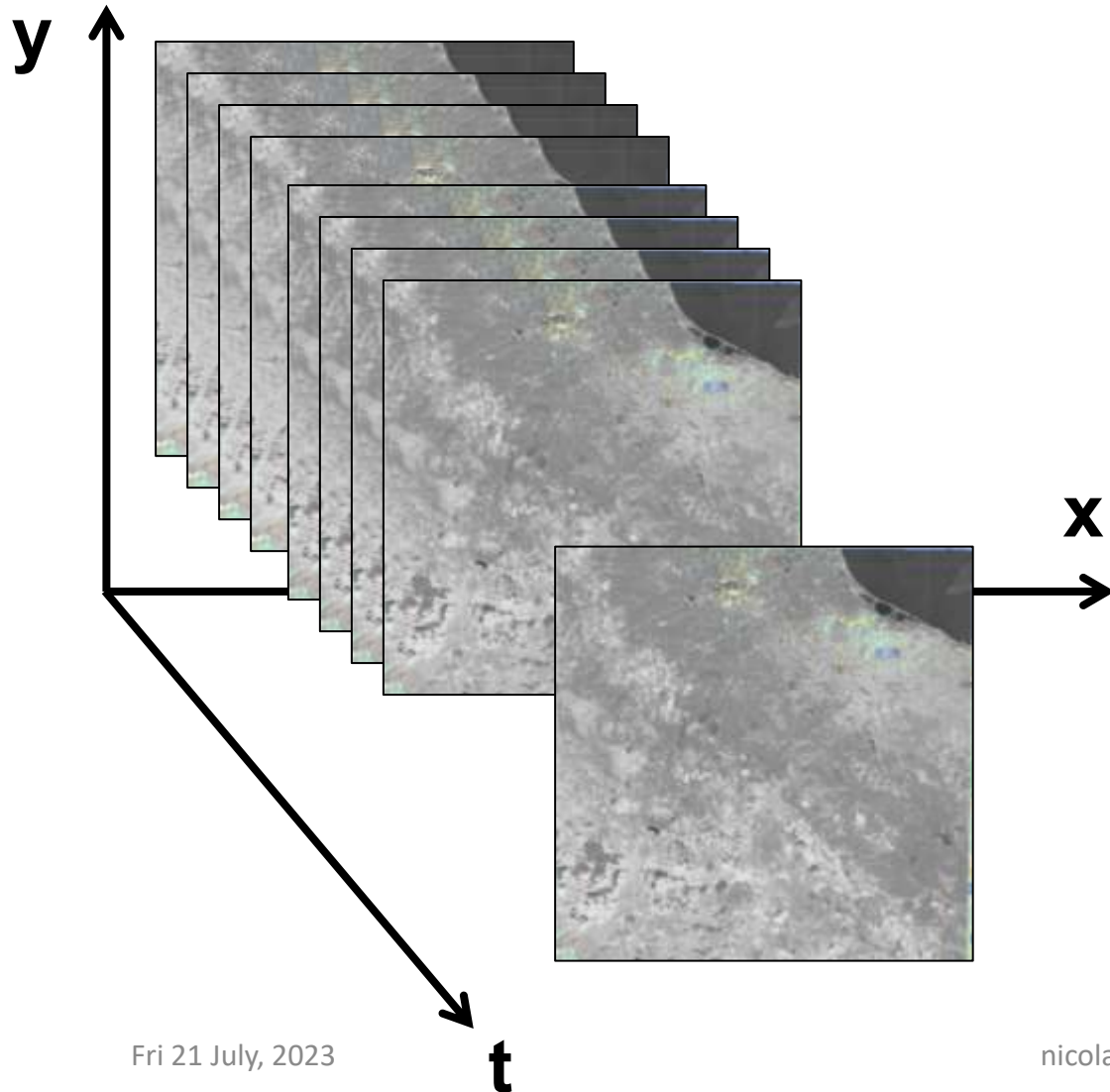
$$\otimes_{NDVI}(x, y, t) \equiv \frac{NDVI(x, y, t) - \mu_{NDVI}(x, y)}{\sigma_{NDVI}(x, y)}$$
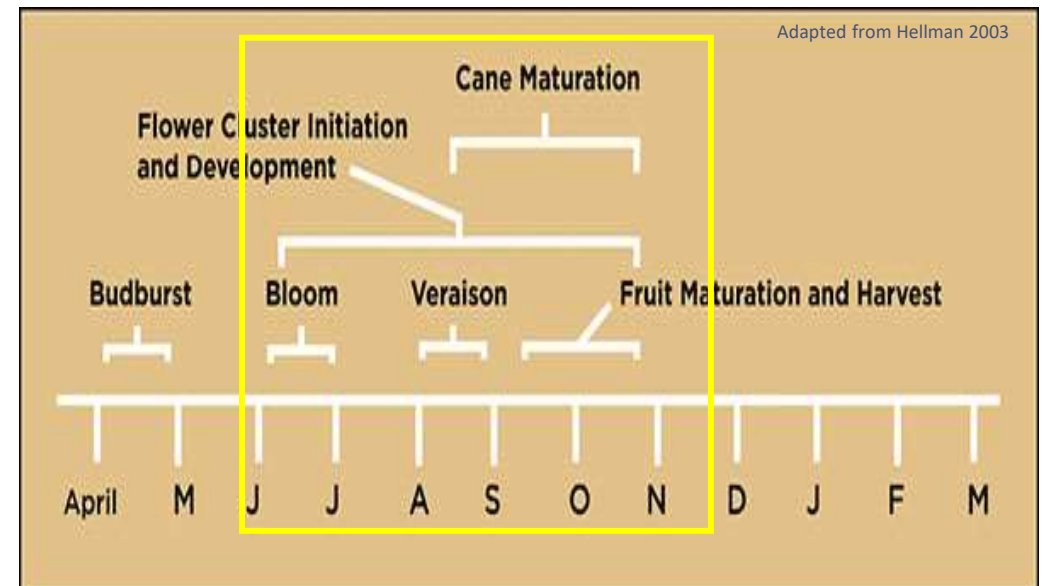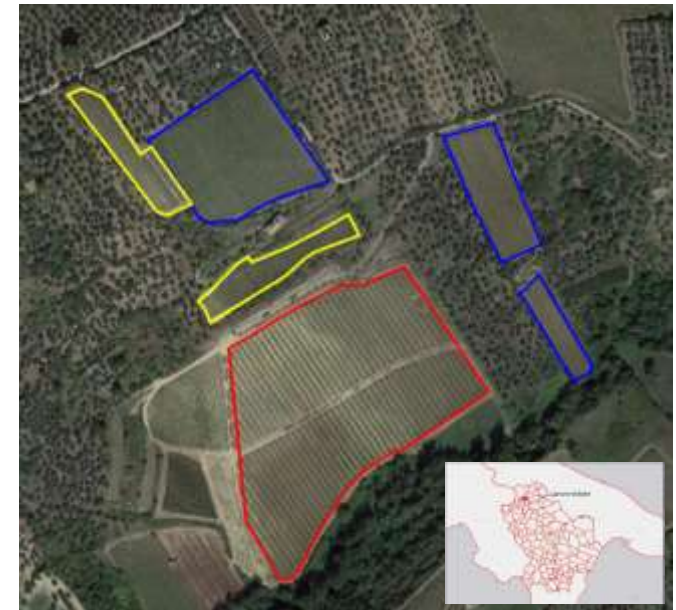
$$NDVI = \frac{NIR - RED}{NIR + RED}$$

$\mu(x, y)$ and $\sigma(x, y)$ computed over all Sentinel-2/MSI images collected in the same period (fortnights) of the year in the years (2015-2022)
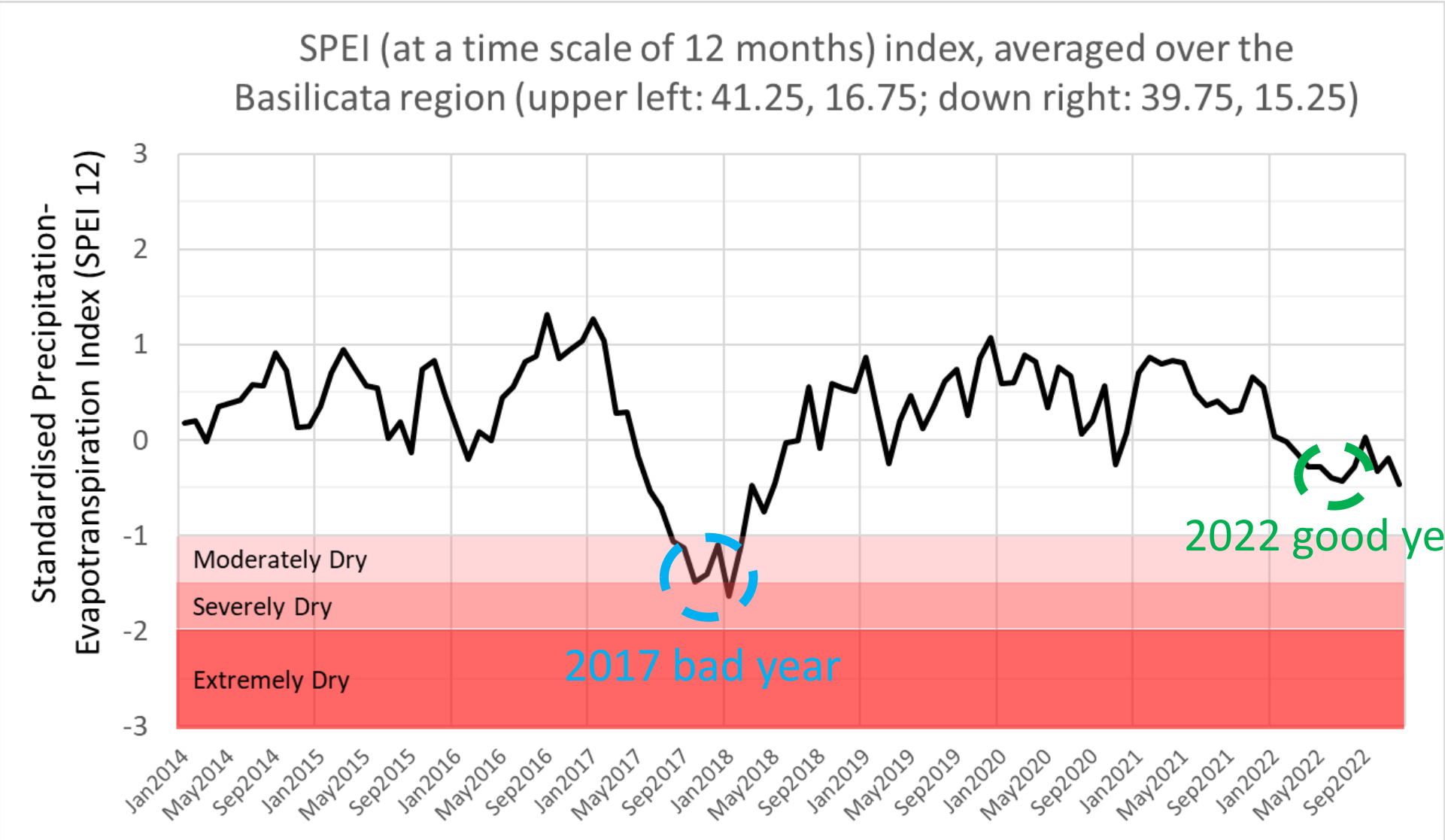
Google Earth Engine

Test sites and test periods

Vineyards located in the northern part of the Basilicata region

✓ ~ 9 hectares

✓ 500 meters above sea level

✓ mainly exposed in NE direction

✓ Aglianico del Vulture plants

Adapted from Hellman 2003

Test sites and <u>test periods</u>

SPEI (at a time scale of 12 months) index, averaged over the Basilicata region (upper left: 41.25, 16.75; down right: 39.75, 15.25)

Results

28/05/2017 (148)

07/06/2017 (158)
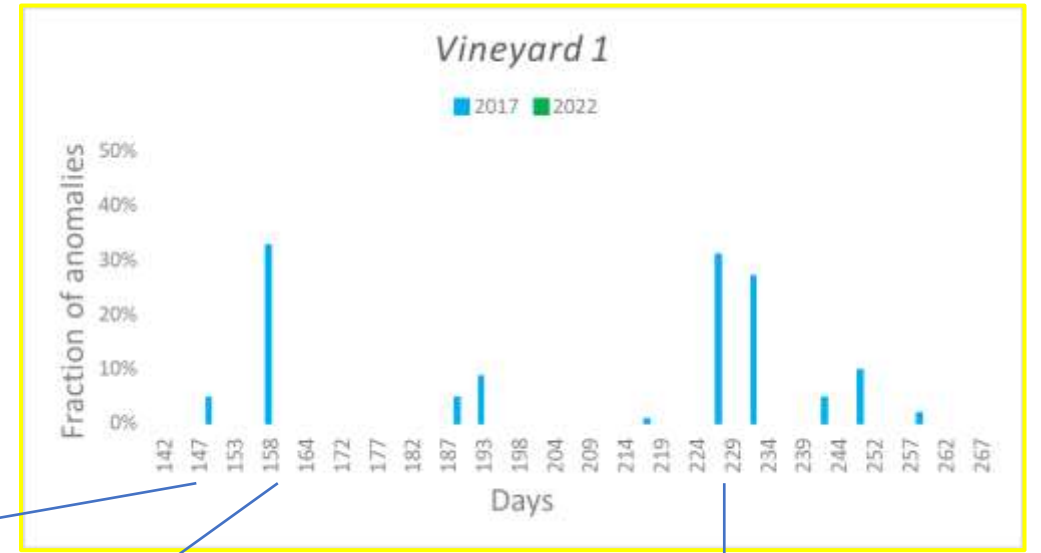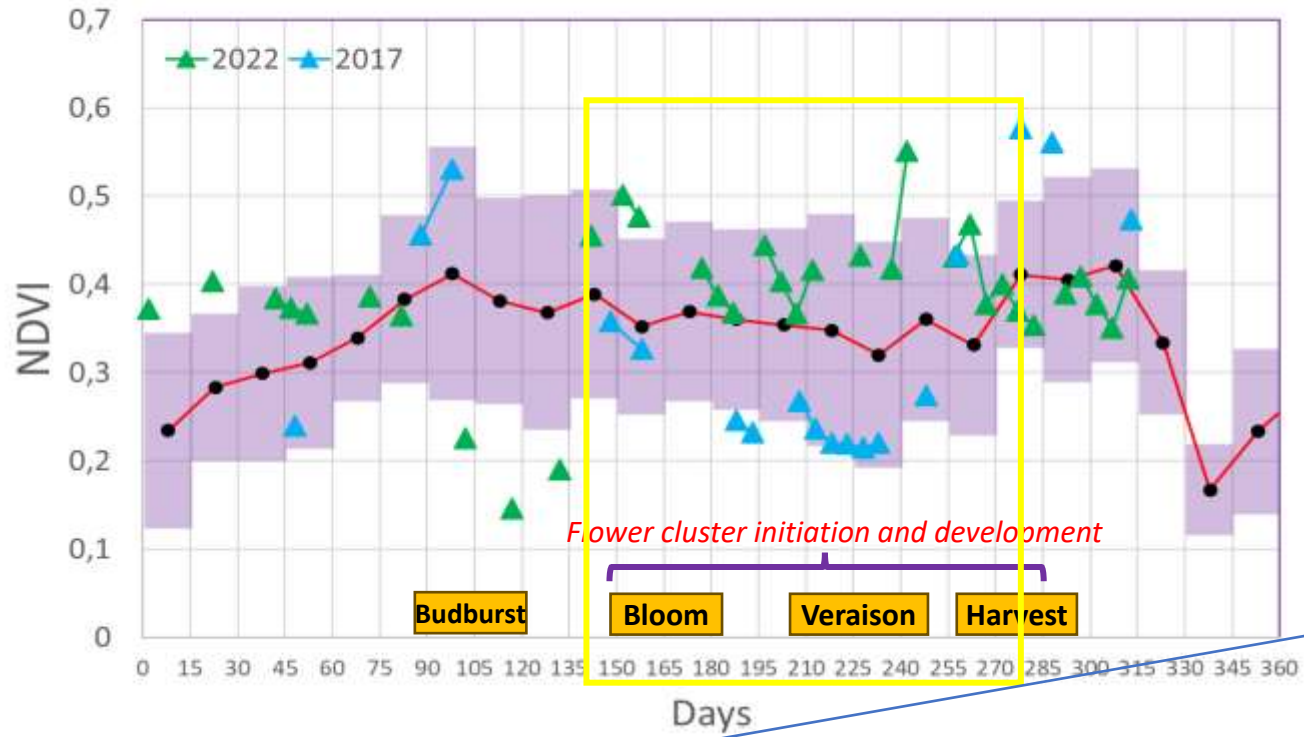
16/08/2017 (228)

(Higher quality well cultivated grapes for red wine)
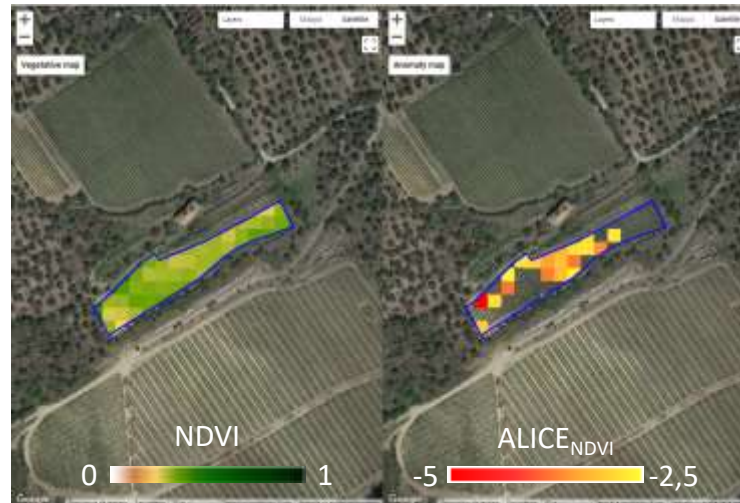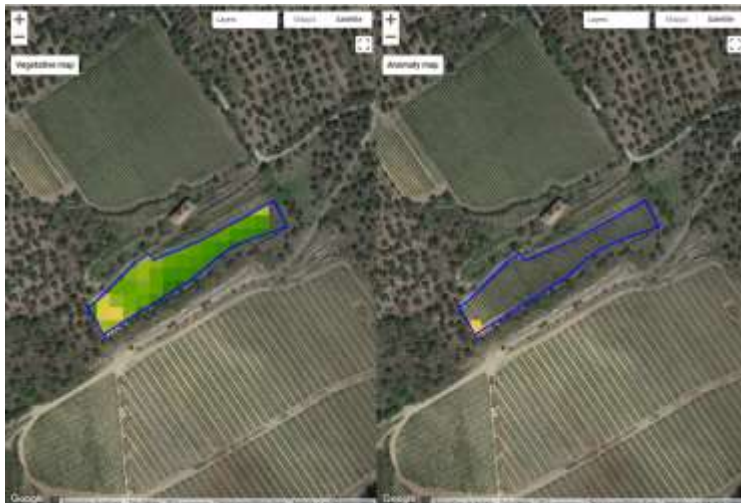
Results
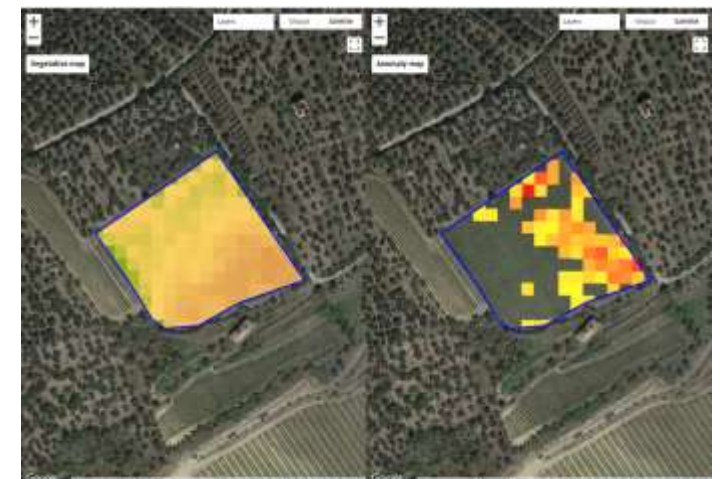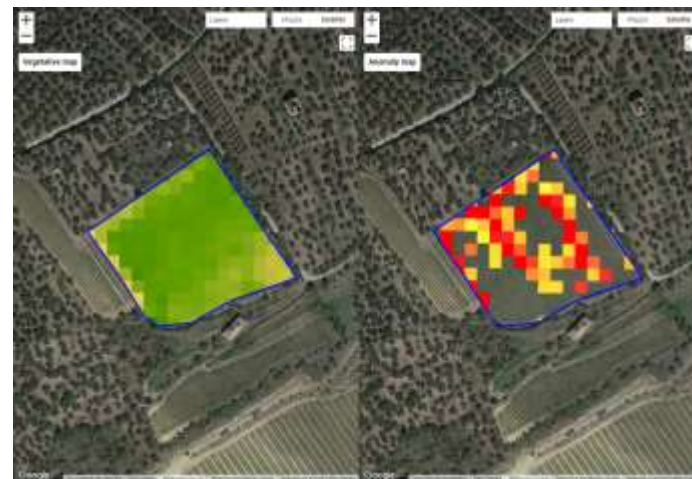
28/05/2017 (148) 07/06/2017 (158) 16/08/2017 (228)
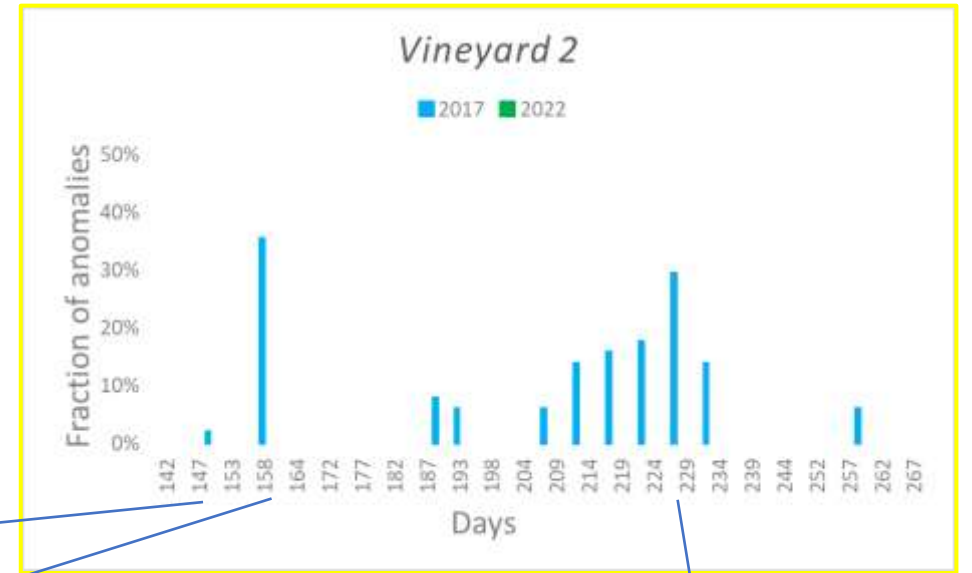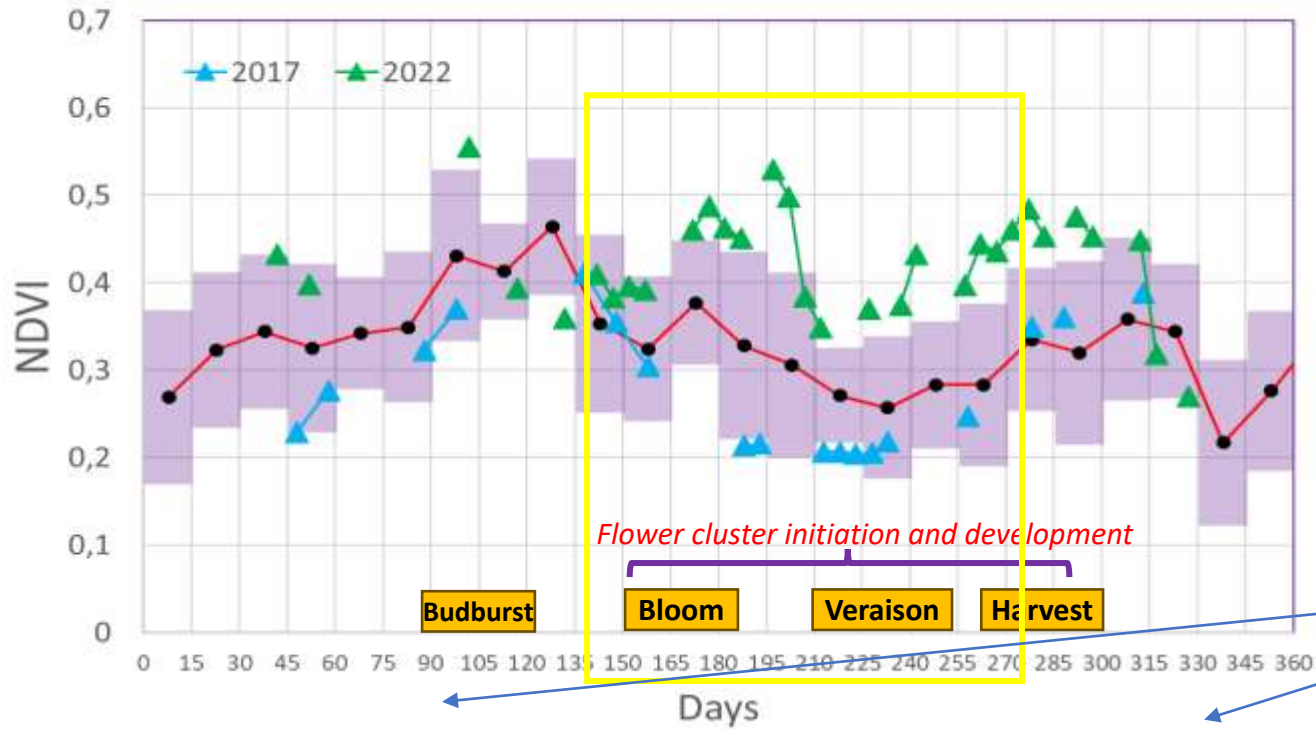
(Higher quality well cultivated grapes for white wine)

Flower cluster initiation and development
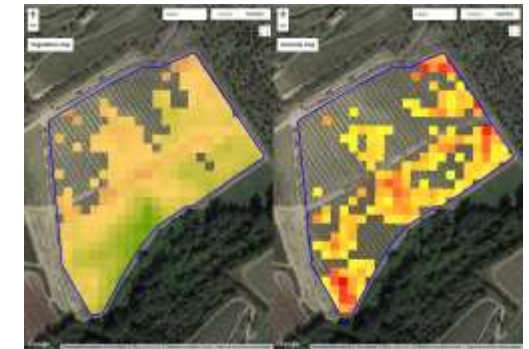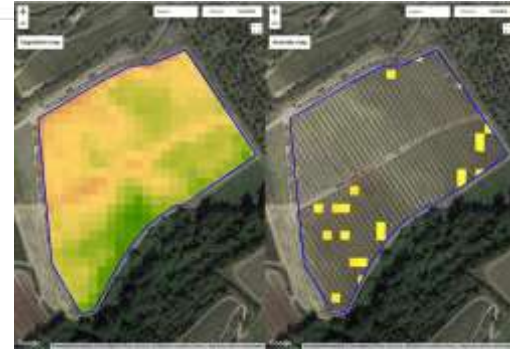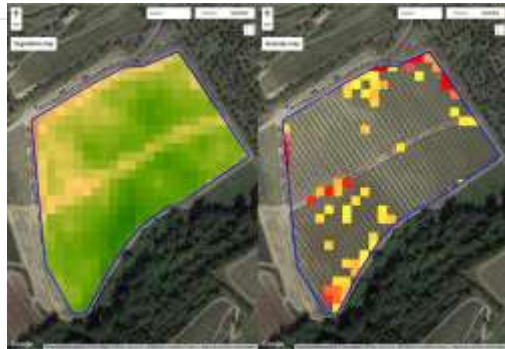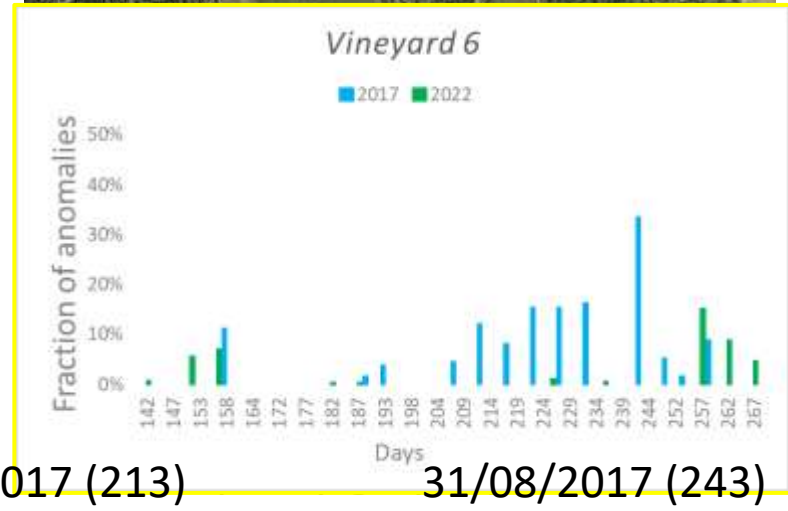
Budburst Bloom Veraison Harvest

NDVI 0 → 1

ALICE_NDVI -5 → -2,5

Results

Vineyard N6

Flower cluster initiation and development

Budburst   Bloom   Veraison   Harvest

Vineyard 6

07/06/2017 (158)   12/07/2017 (193)   01/08/2017 (213)   31/08/2017 (243)

22/05/2022 (142)   01/06/2022 (152)   06/06/2022 (157)   15/08/2022 (227)

NDVI   ALICE_NDVI
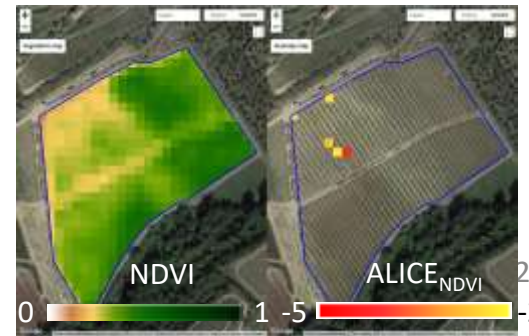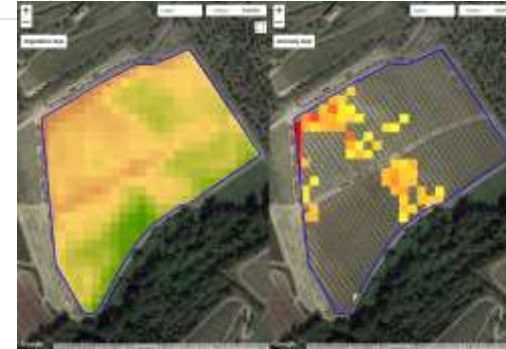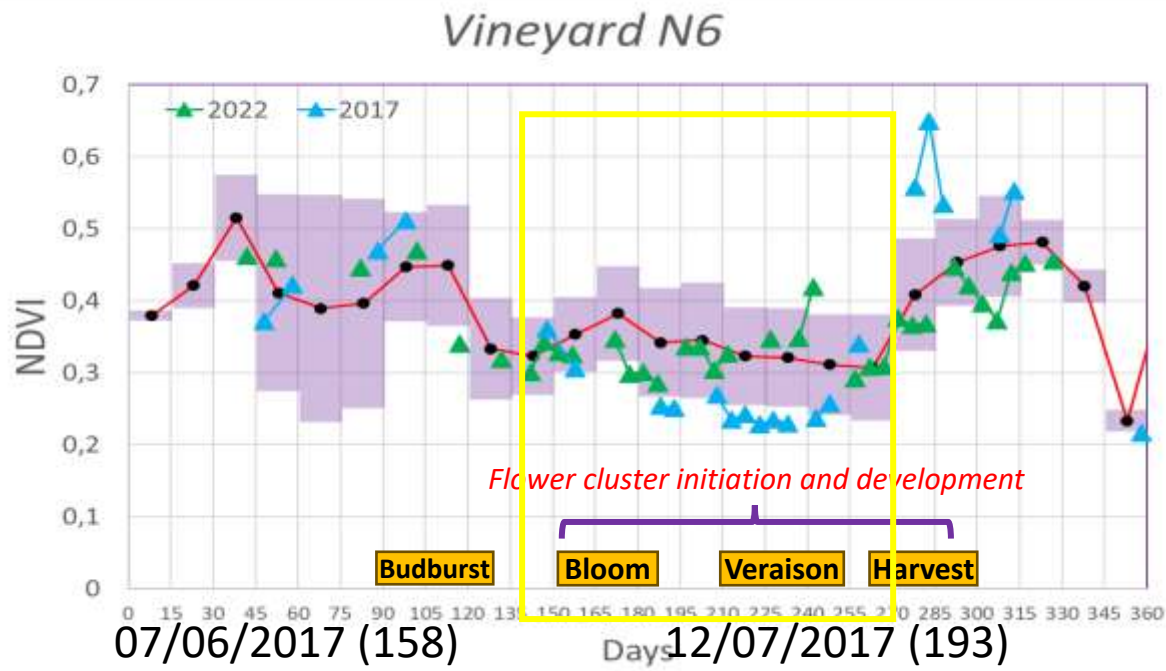
A tool to support winemakers
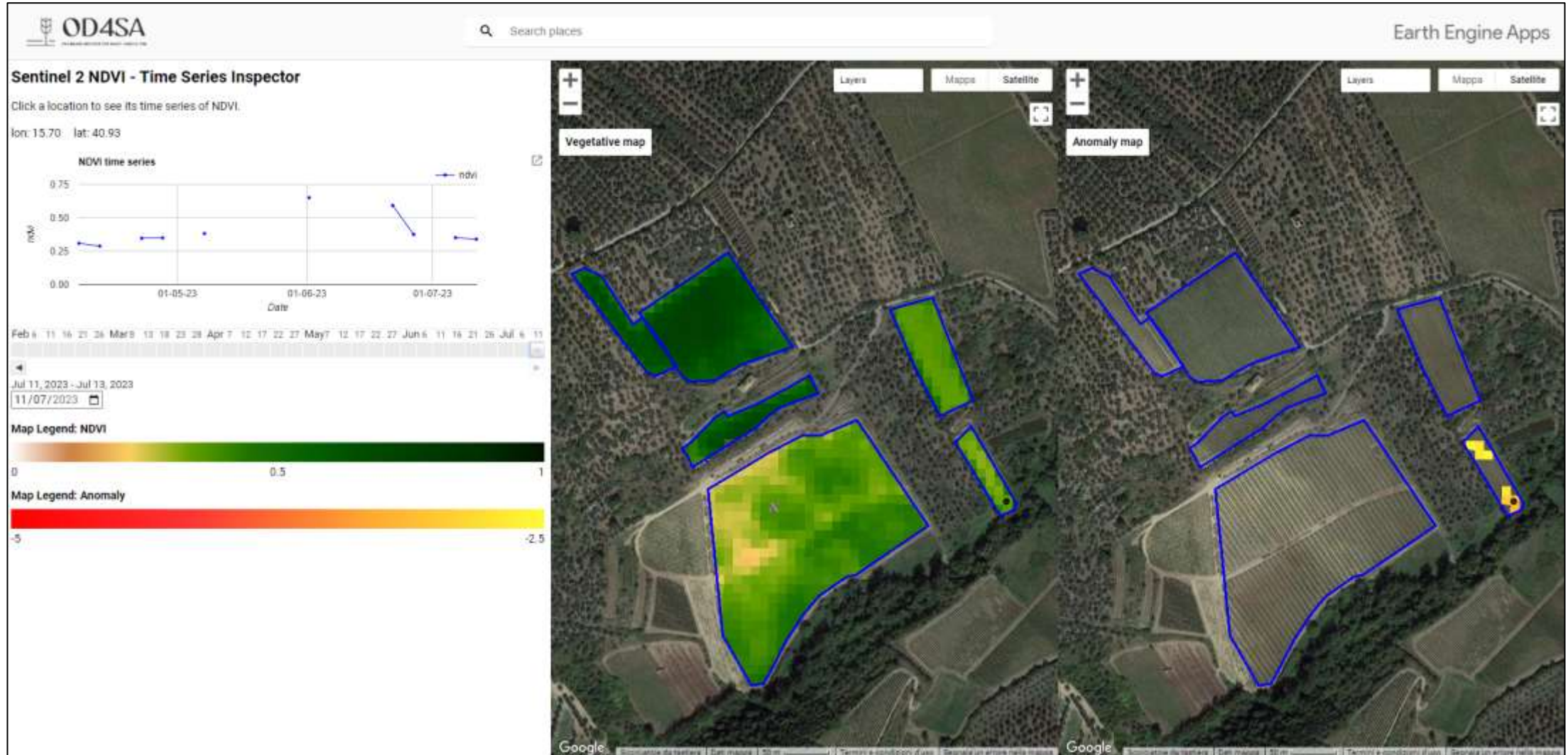
Summary and conclusions

➢ Vineyard phenology strongly variable depending on local site conditions (soil, exposition, slope, etc.)

➢ In order to early detect and map significant anomalies refined methods are required

➢ RST approach provides:

  ➢ timely information on vineyard response to climatological forcing

  ➢ detailed maps in order to operate selective counter-mesures
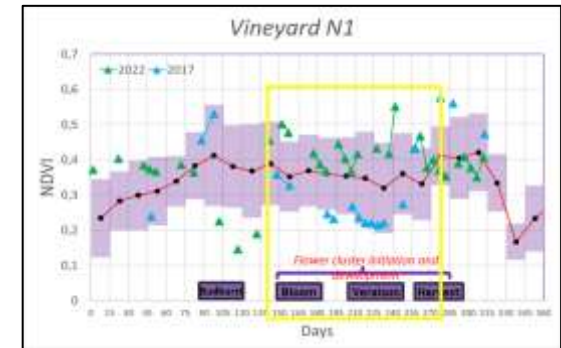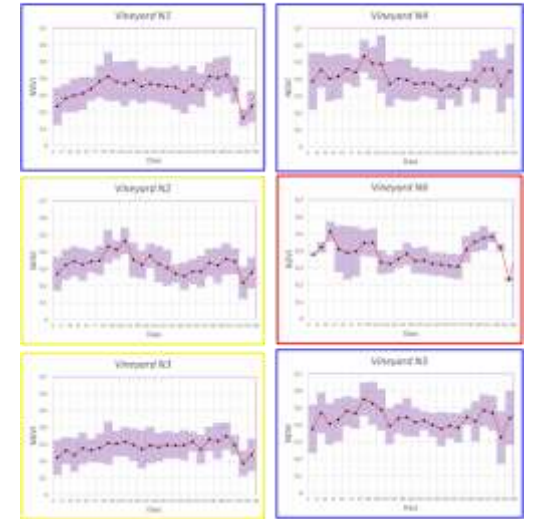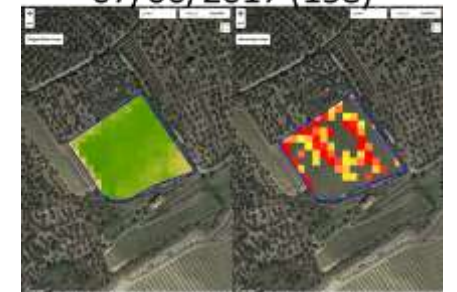
Thanks for the attention

Acknowledgements