e-shape

EuroGEO Showcases: Applications Powered by Europe

EU-CAP Support pilot

A system for dynamic phenology estimation and yield prediction using satellite and in-situ observations

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BEYOND
Centre of EO Research
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ΕΘΝΙΚΟΝ ΑΣΤΕΡΟΣΚΟΠΕΙΟΝ ΑΘΗΝΩΝ
NATIONAL OBSERVATORY ATHENS

IAASARS

EuroGEO GEO GROUP ON EARTH OBSERVATIONS Copernicus

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Outline

- Copernicus program for Agriculture
- Copernicus data
- Pilot objectives and the e-shape paradigm
- Auxiliary data
- Mock examples of the developed and developing services
- Take home message

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The Copernicus program

The Copernicus program for Agriculture

EC targets the development of **agricultural practices for the preservation of the environment and the sustainable productivity**

- Agriculture is one of the **first domains** to exploit **earth observation data**
- Agriculture is probably the most **promising market** for the Copernicus program
- Copernicus **allows for the monitoring** of
  - Land use and trends of the agricultural land
  - Cultivating conditions, crop health and crop growth
  - Crop yield
- Copernicus **supports farm management** – inputs and irrigation
- The application domains of Copernicus do not only limit to smart farming:
  - Seasonal mapping of agricultural land
  - Food security monitoring
  - Water management and monitoring of drought
  - Subsidy control and monitoring

Data of the Copernicus program – Sentinel 1 & 2

Sentinel satellites

- Images of optical spectrum
- Images of the microwave spectrum (radar)

Image acquisitions every 5/6 days

- Dense time-series of Sentinel data
- Full capture of crop growth
- Timely monitoring of agricultural land

Global coverage

Applications of national, pan-European and global scale

- Monitoring of food security
- Monitoring of the CAP
- Monitoring of agricultural ecosystem services and climate change

High spatial resolution (10 and 20 m)

- Thematic information at the parcel and intra-parcel level
- Smart farming and precision agriculture
- Evidence-based decision making

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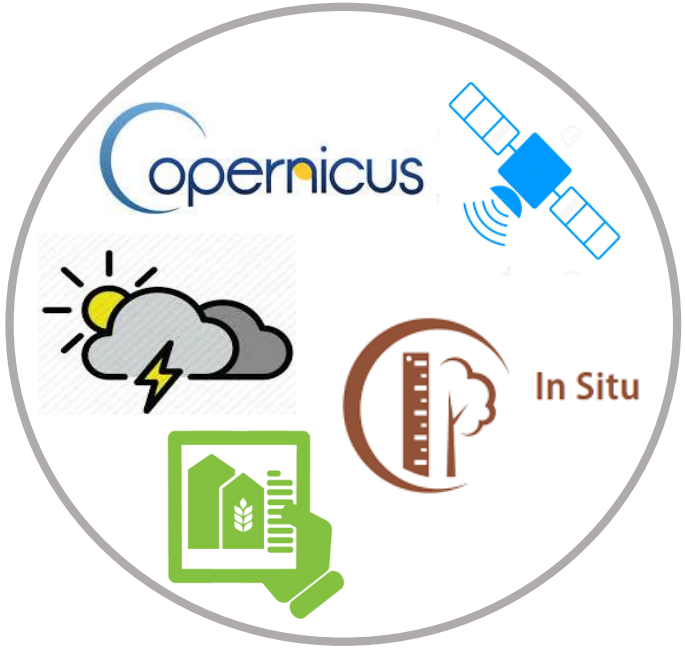
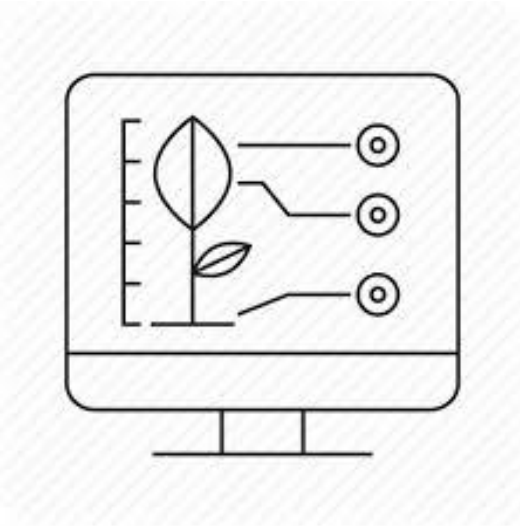
The pilot

e-shape EU-CAP Support pilot

- Support farmers towards the **transition from CAP compliance to Farm performance**
- Assist the farmer in **utilizing EO-based smart farming services**
  - Support CAP compliance but also **increase the production, decrease the costs, while applying sustainable practices**
- Showcase that **Copernicus datasets** combined with the necessary in-situ data, weather and soil data can **deliver improved information products for actionable advice on crop growth and yield**





Co-design approach and Potential users

- Co-design with a smart farming/agriculture consulting company (NEUROPUBLIC/GAIA EPICHEIREIN)
  - Design, prototype, evaluate, fine-tune, test the produced services together with the user
  - Continuously engaging new users, customize the general and reusable tools that are being developed
  - Consider the commercialization, the sustainability and uptake of the developed services even from the design phase
- Other potential users of the developed system and its services
  - Farmer cooperatives/farmers
  - Insurance companies
  - Common Agricultural Policy (CAP) stakeholders

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Auxiliary data

Data from the co-designer – Neuropublic/GAIA EPICHEIREIN

Gaiatron Stations collect data related to atmospheric, soil and biological parameters, such as air and soil temperature, relative air and soil humidity, soil salinity, leaf moisture, rainfall, solar radiation, etc.

Crop calendars

	id	scsd_description	Date
0	49353	Seeding	2018-05-01
1	49353	Germination	2018-05-10
2	49353	First Leaf	2018-05-15
3	49353	First Square	2018-06-30
4	49353	First flowers	2018-07-10
5	49353	Flowering	2018-07-15
6	49353	First Bolls	2018-07-20
7	49353	End of Flowering	2018-08-01
8	49353	Boll Development	2018-08-10
9	49353	Boll Opening	2018-08-20
10	49353	Harvest	2018-09-27

Greek Agricultural Insurance Organization (ELGA) data

- Data regarding years 2016-2019
- Data include among others the following:
  - Average production over the years
  - Expected yield
  - Amount of Compensation
  - Damage extent
  - Cause of Damage

area	avg_produc	damage_per	yield_esti
48.200000...	400	80	19280.000...
4.7000000...	400	80	1880.0000...
2.1000000...	350	80	735.00000...
4.0000000...	350	80	1400.0000...
8.5000000...	350	80	2975.0000...
3.4000000...	180	80	612.00000...
15.600000...	370	80	5772.0000...
9.4000000...	150	80	1410.0000...
5.0000000...	280	80	1400.0000...

Validated in-field data

- 2020 campaign
- In-situ measurements
- High quality information
  - 3 sites in every parcel
- Validated phonological stage observations
- Validated yield

Date: 10/09/2020
Parcel: 58909
BBCH: 82
Point A: 41.1091601, 25.5063808
Point B: 41.1088317, 25.5063520
Point Γ: 41.1084737, 25.5061236

Number of plants	Point A			Point B			Point C		
	Nodes	Bolls	Height	Nodes	Bolls	Height	Nodes	Bolls	Height
1	16	13	101	19	18	98	14	9	75
2	17	13	94	14	4	76	15	14	92
3	13	5	71	16	9	89	17	9	98
4	15	8	86	18	19	97	21	17	102
5	11	3	51	17	17	95	19	8	84
6	14	6	85	15	8	81	14	6	77
7	15	8	89	17	13	97	16	11	83
8	13	5	73	18	21	98	18	11	87
9	17	12	101	14	8	77	14	5	66
10	11	2	63	14	1	63	12	4	63
11	16	8	83				15	6	72
12	14	6	80				12	7	64
13	13	6	72				18	10	83
14	15	10	82				15	11	64
15	12	3	62						
16	12	4	78						
17	15	9	83						
18	13	9	77						
19	12	4	67						
20									
21									
22									
23									

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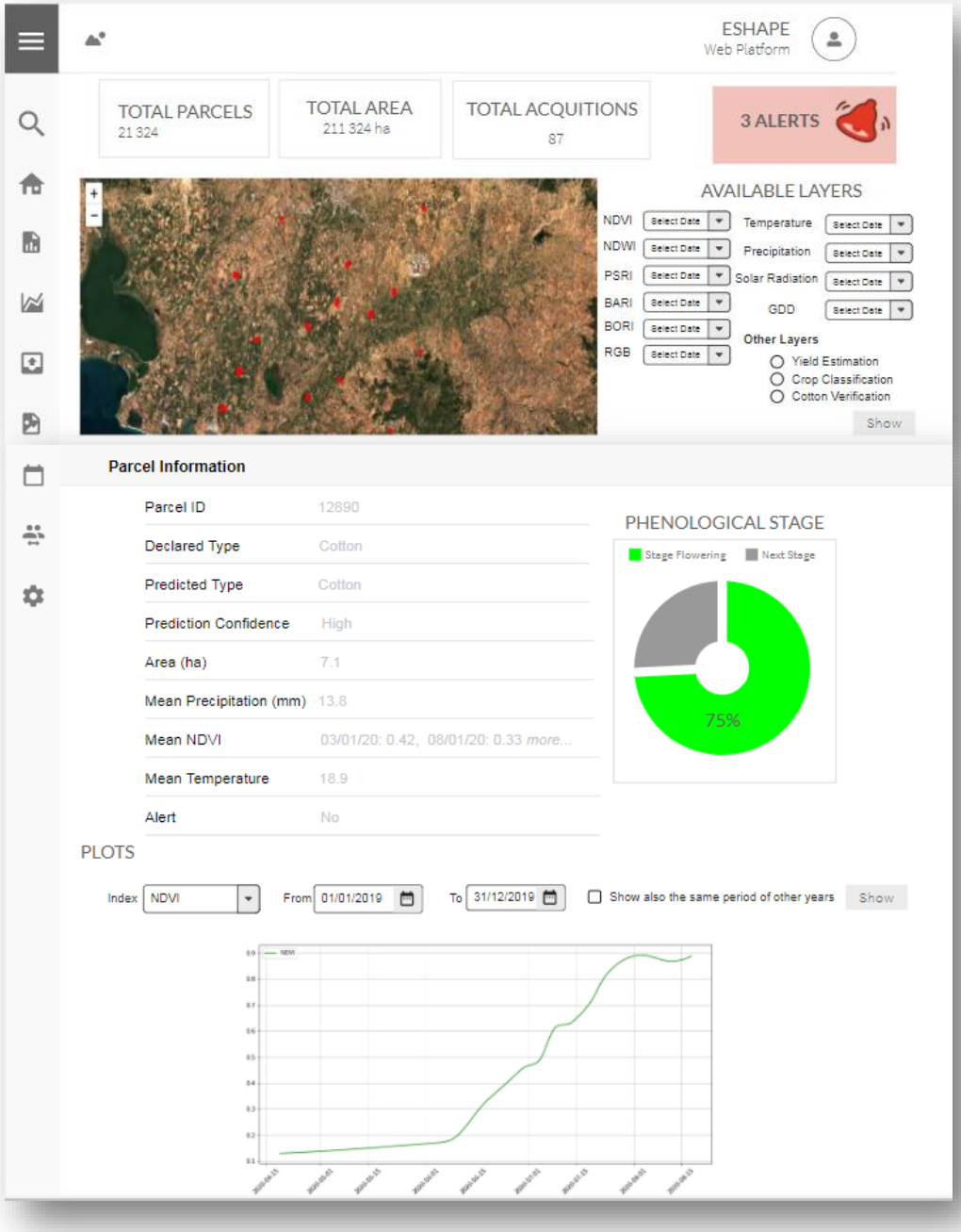
The prototype

Pilot prototype: Modules and Functionalities

- **Interactive maps** for dynamic phenology prediction and yield estimation **at the parcel level**
- **Time-lapse on map layers** for the visualization of several parameters such as vegetation indices, meteo indices, soil indices
- **Crop classification layer** along with the confidence indices
- **Parameter plots with timestamps** – phenology prediction and percentage of completion; phenology forecasting
- Alerting mechanism for discrepancies in declared crop types
- Parcel based statistical report

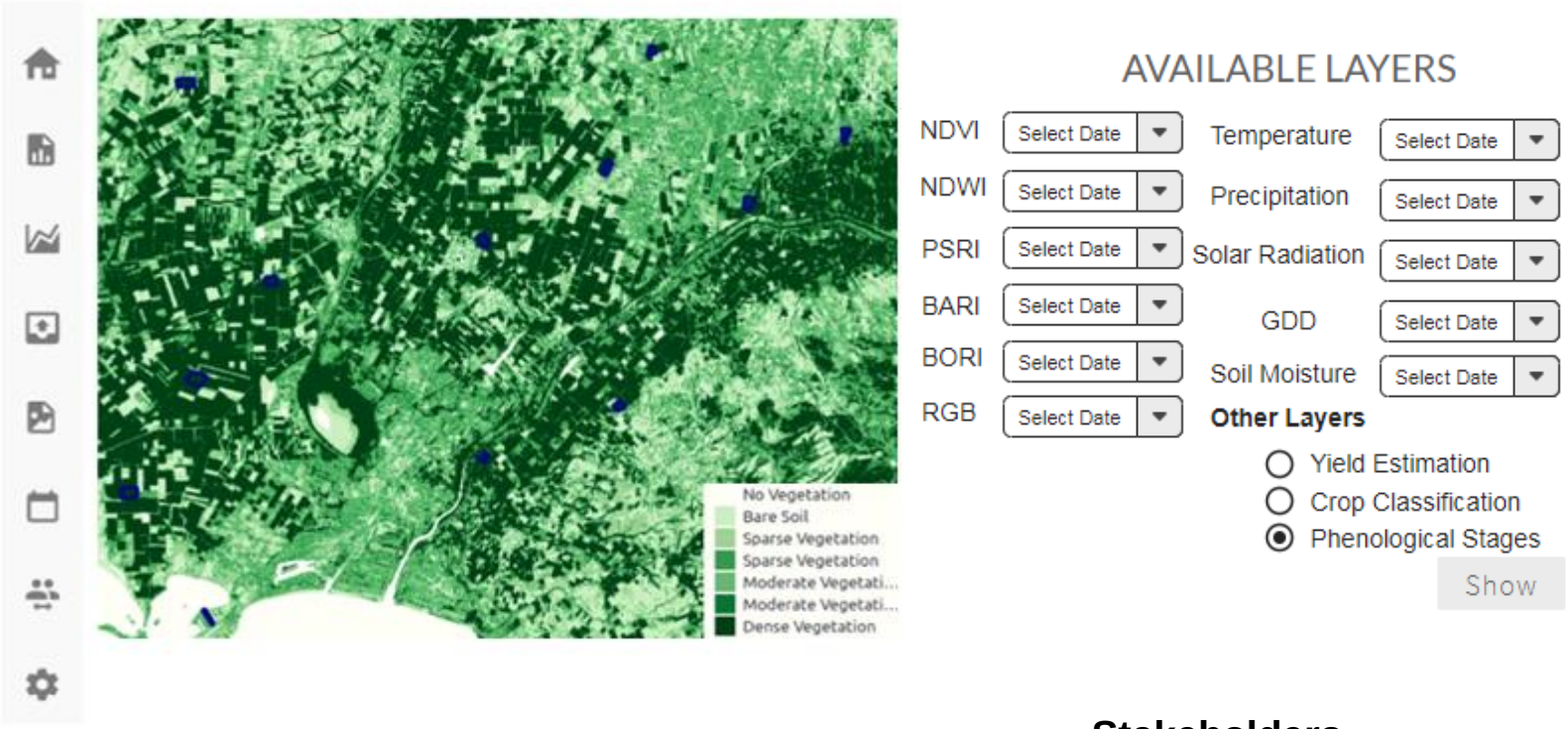
The application

- ✓ Interactive Map
- ✓ Parameters and Products menu
- ✓ Parcel Report
- ✓ Parameter and Product plots
- ✓ Alerts layer



Qualitative indices on vegetation, health and growth

- Copernicus based vegetation and soil indices and meteorological parameters from numerical models and in-situ observations

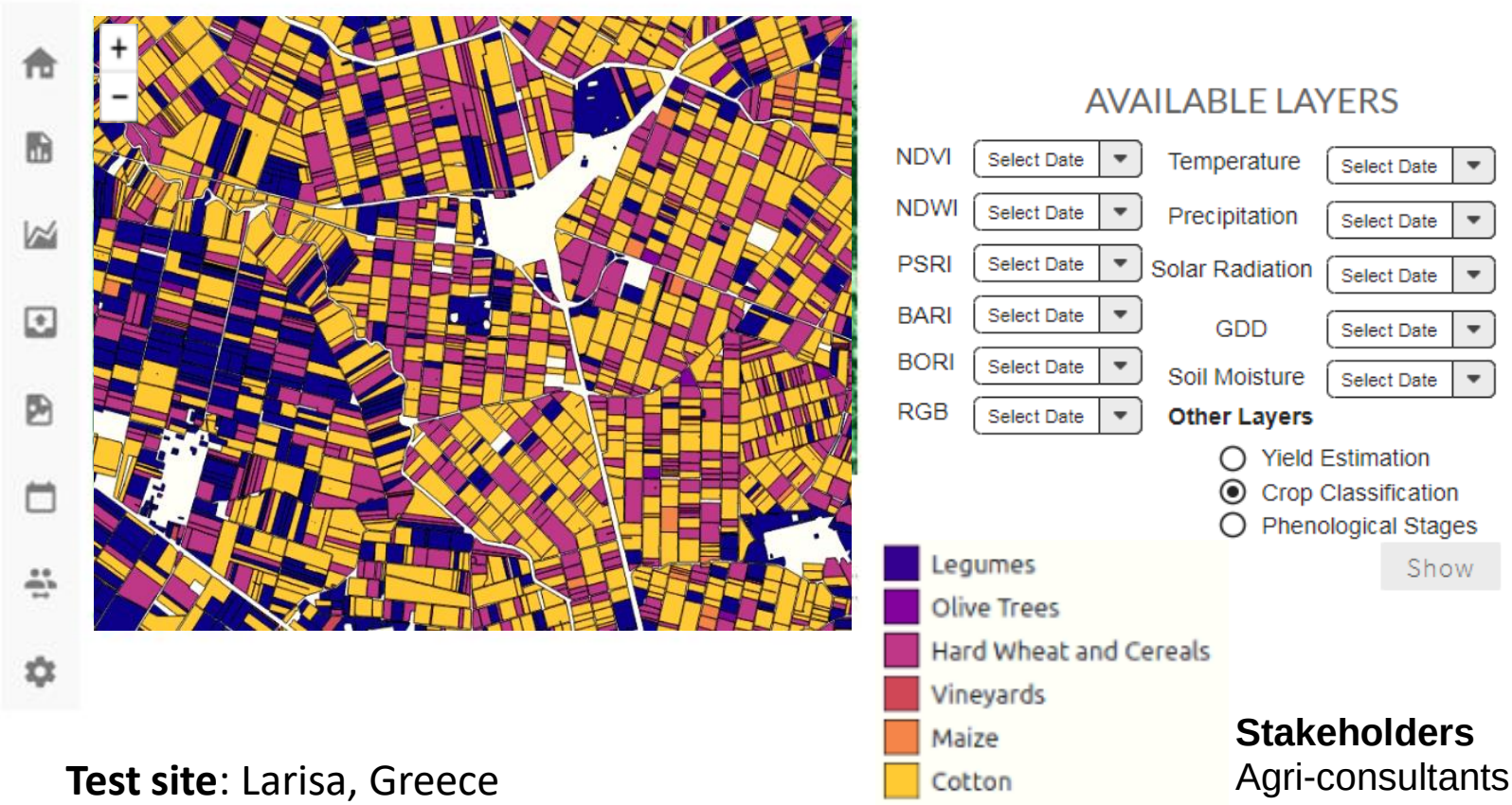


Test site: Komotini, Greece
Crop type: Cotton

Stakeholders
Insurance
Agri-consultants
Farmers
Paying agencies

Crop Classification layer

- Machine learning based crop classification service for multiple crop types
- Can be used at the portal of applications for subsidies



Test site: Larisa, Greece
Crop types: legumes, olive trees, cereals, maize, cotton
Accuracy: >85%

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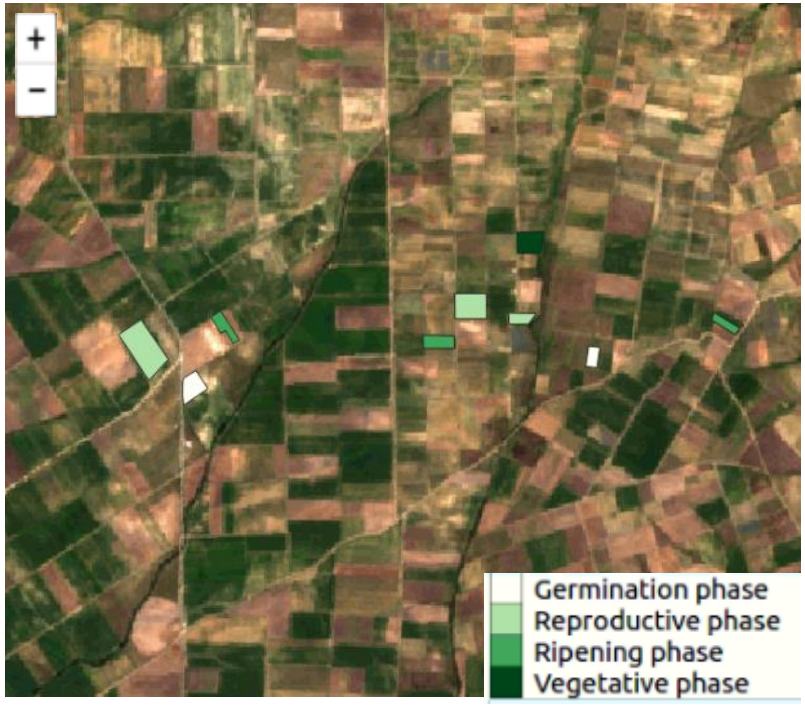
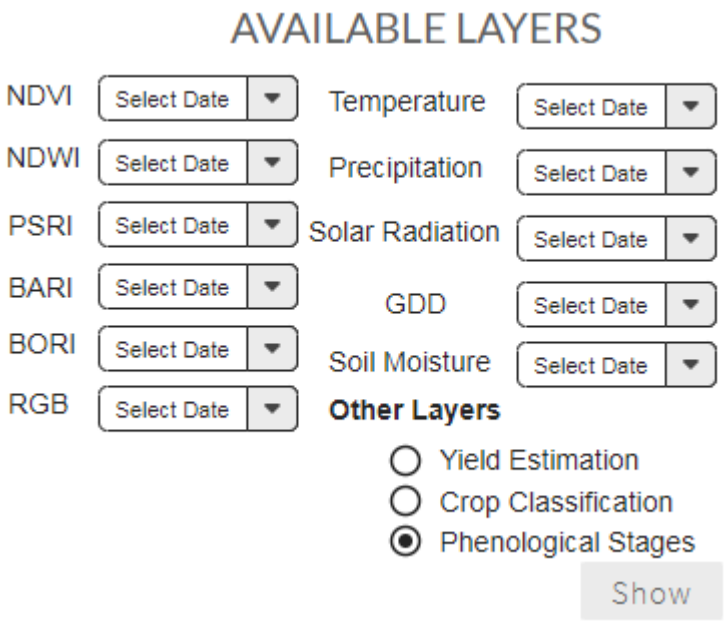
Phenology prediction map layer

- Automated phenology prediction system – new prediction every 5-10 days





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Crop type: Cotton

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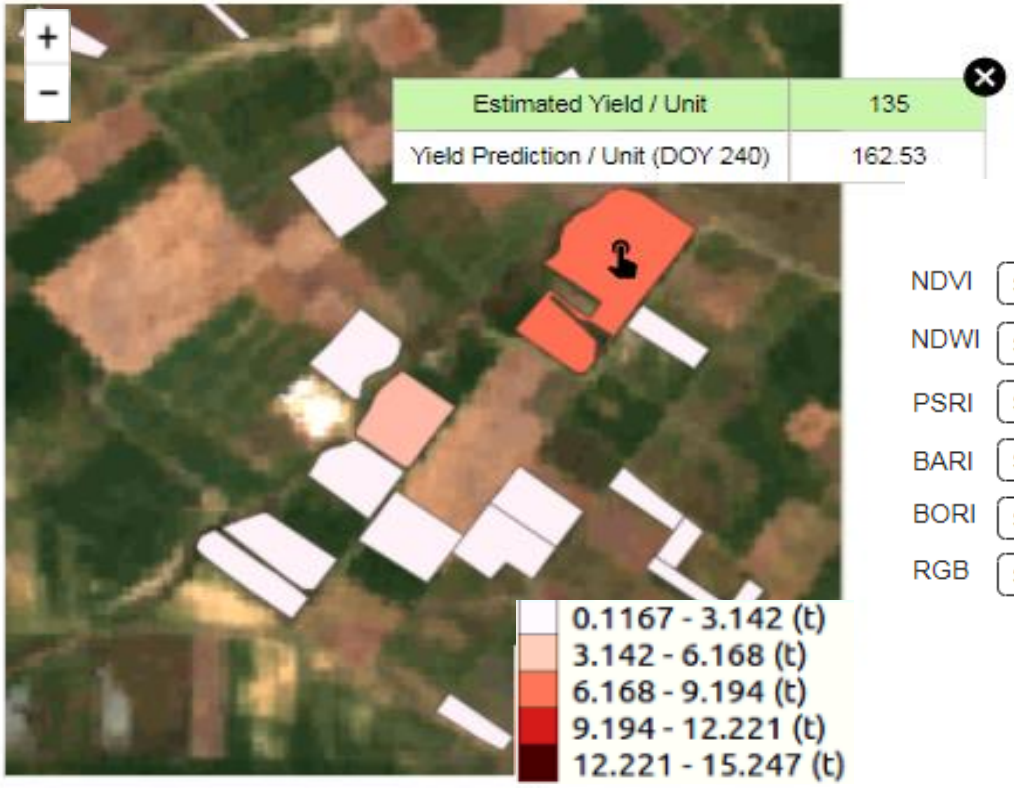
Yield estimation layer

- Machine learning yield estimation in mid-season (cotton)



Test site: Komotini, Greece
Crop type: Cotton

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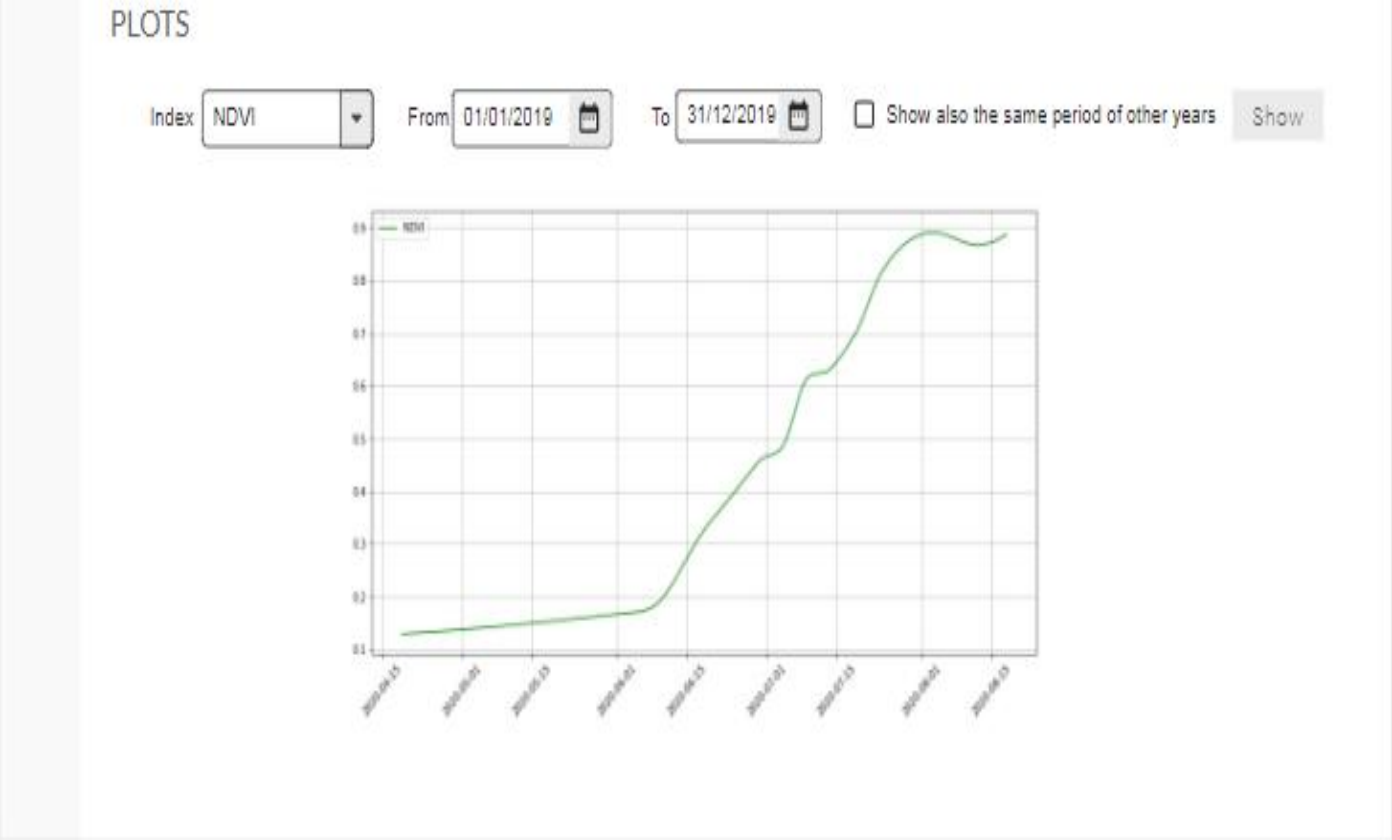
Parcel Information – Vegetation and Soil Index plots



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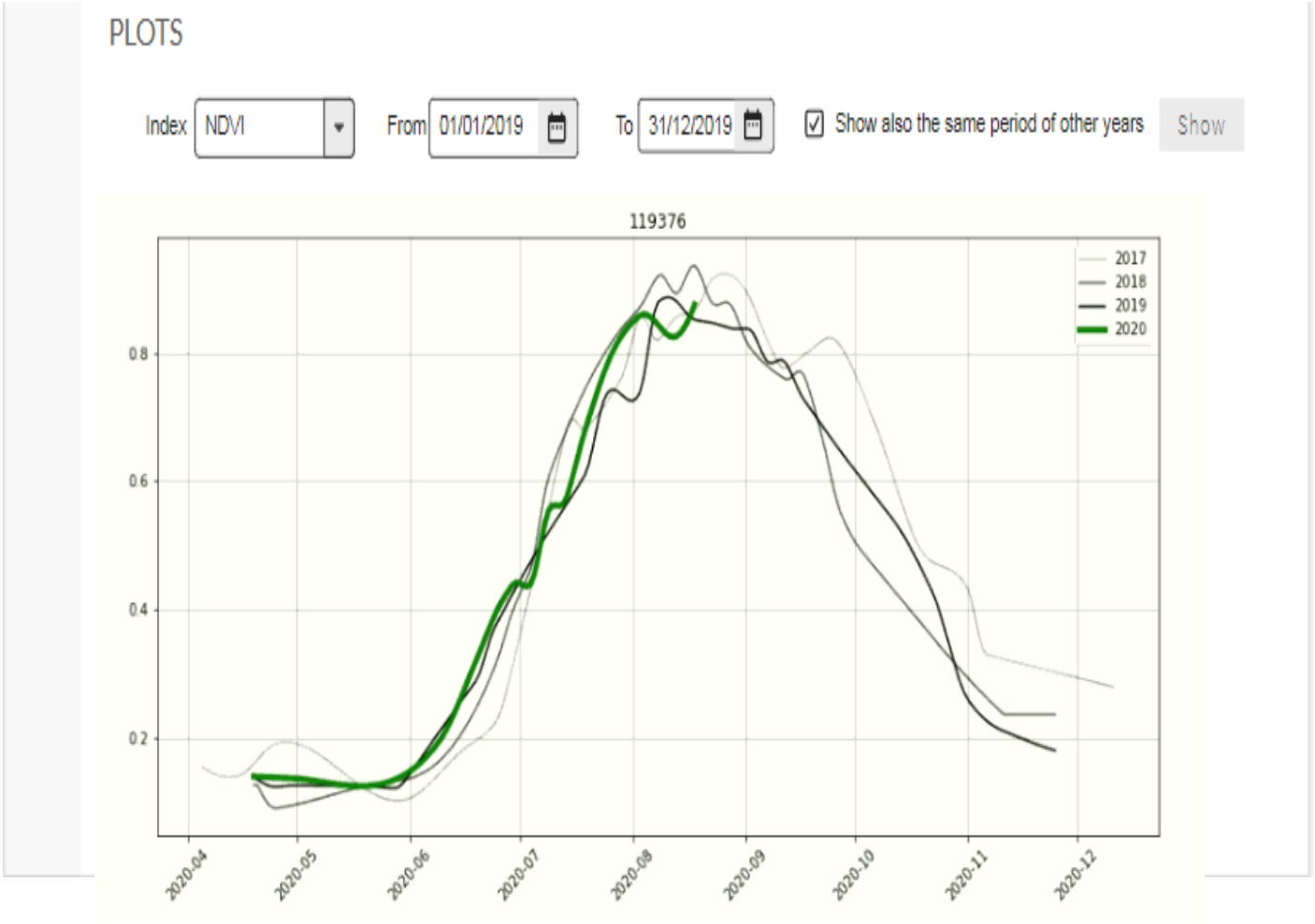
Parcel Information – Parameter plots with over the years comparison



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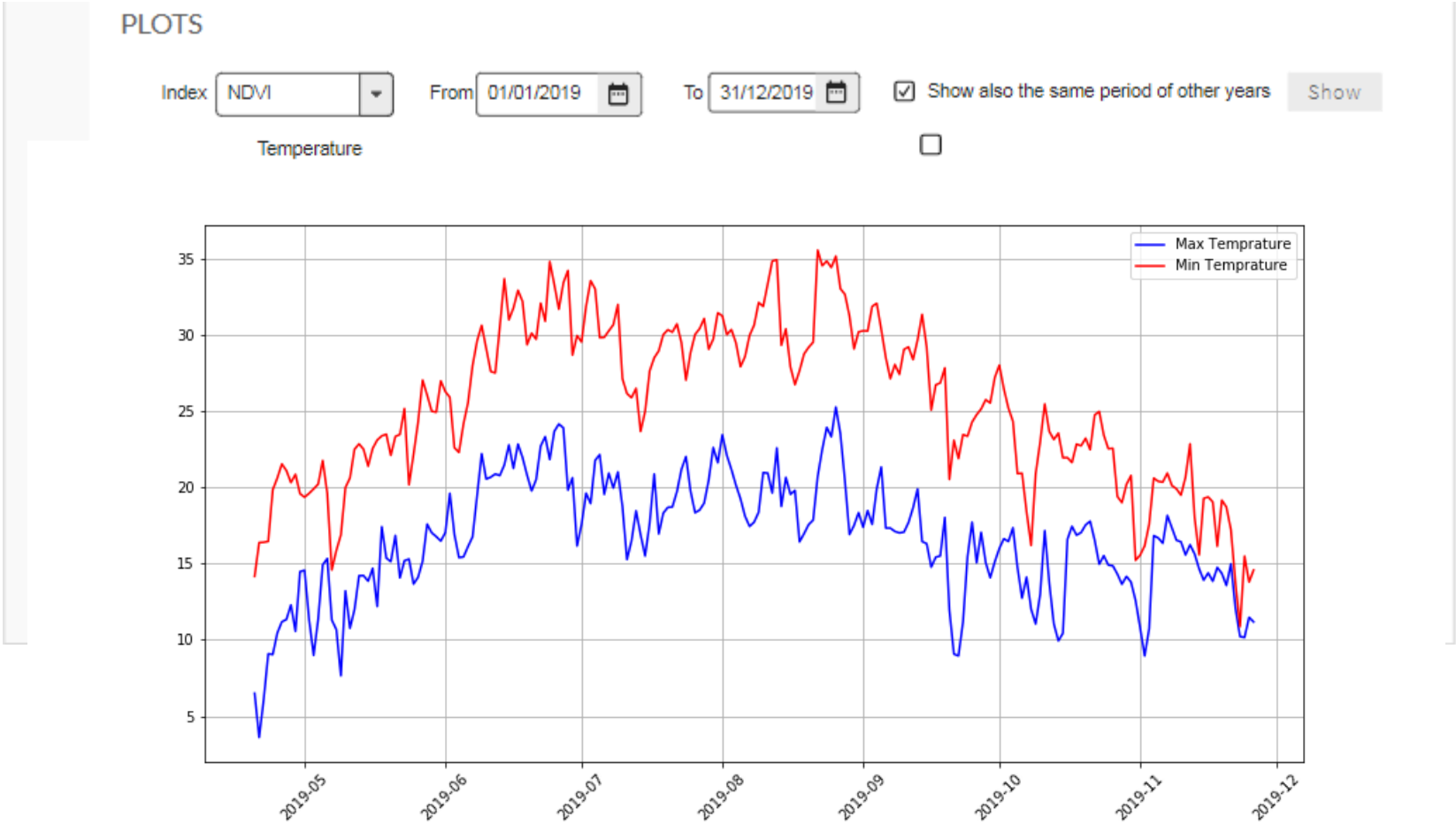
Parcel Information – Plots of meteo data



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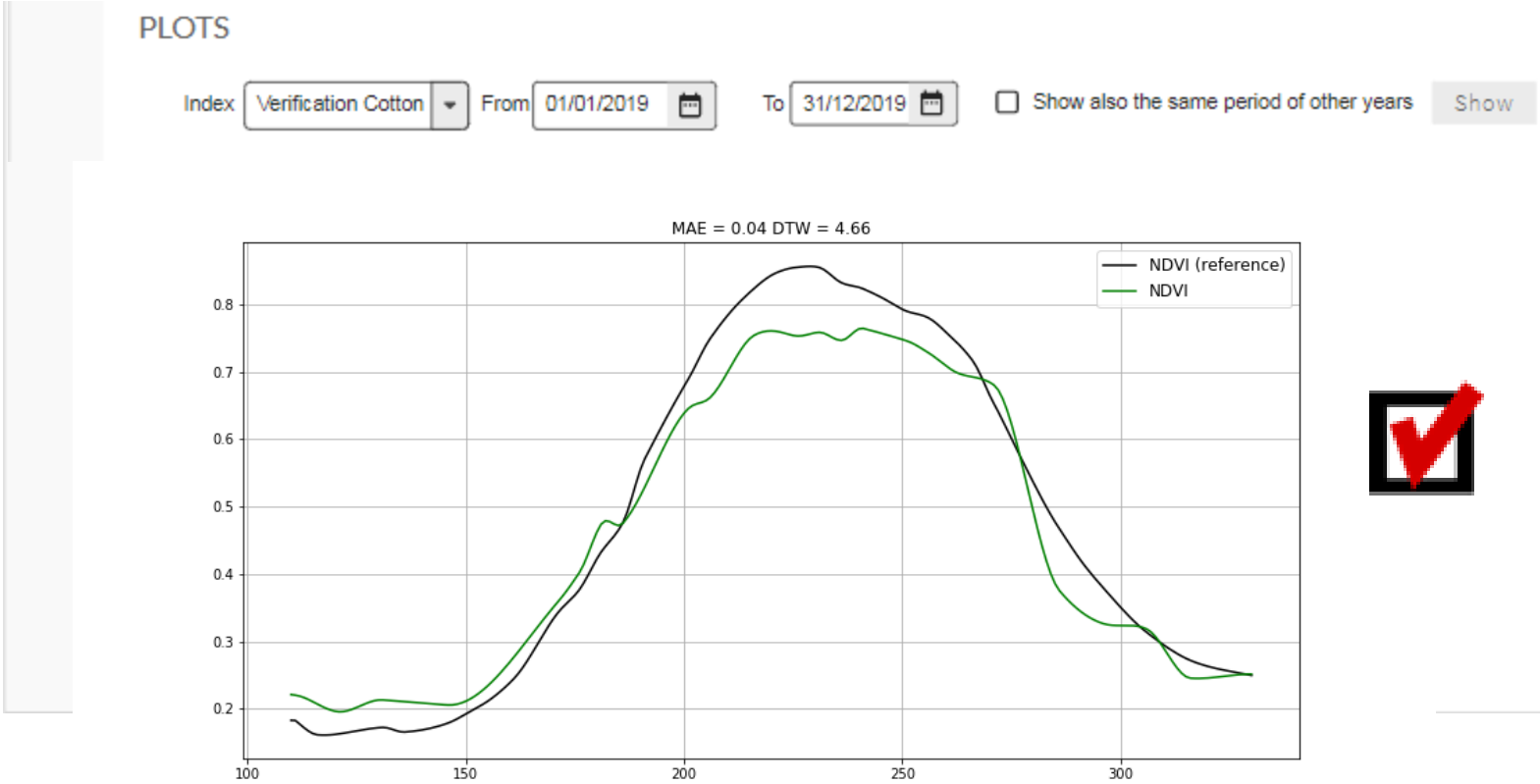
Parcel Information – Verification of cultivated crop type



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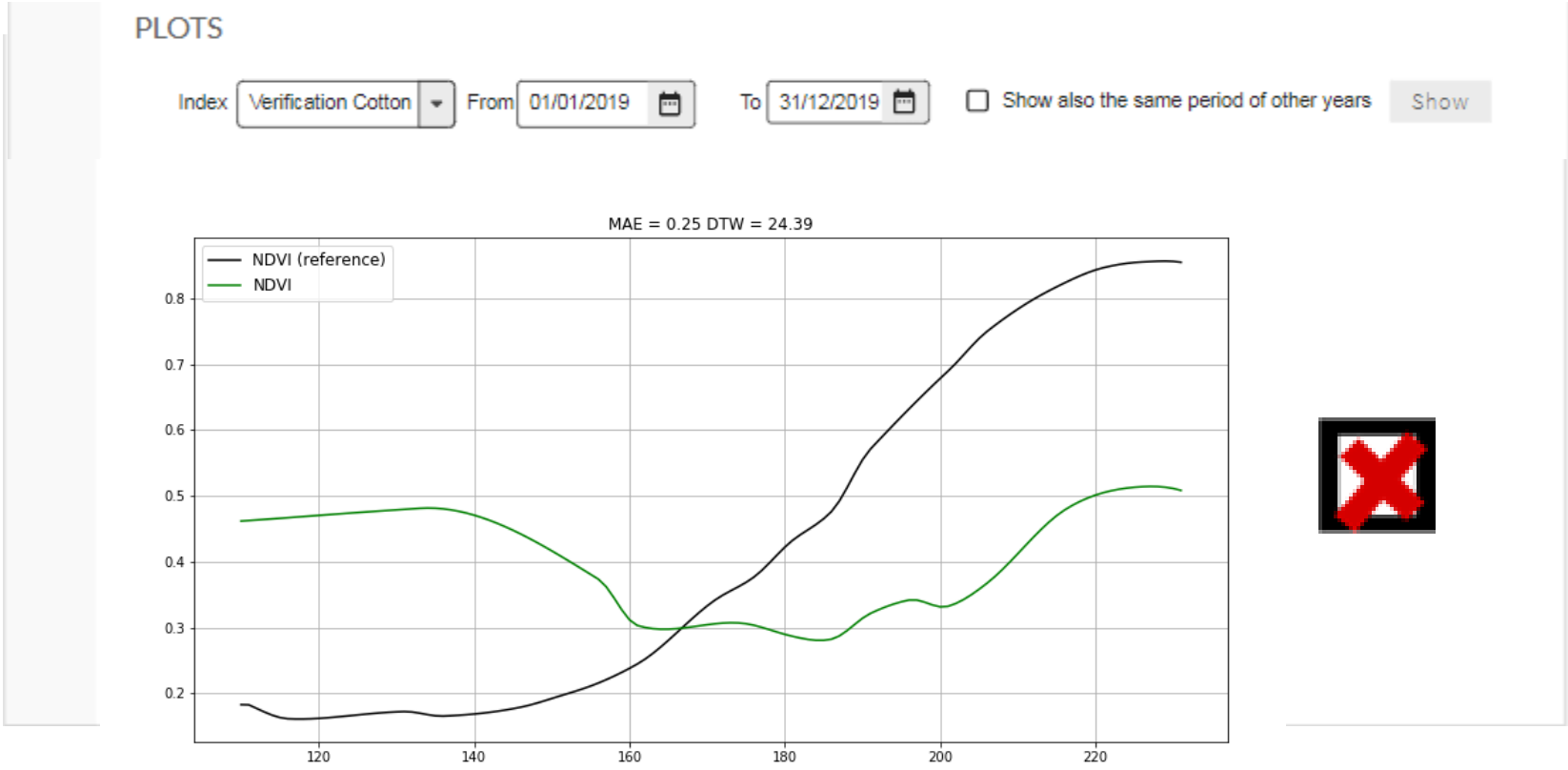
Parcel Information – Verification of cultivated crop type



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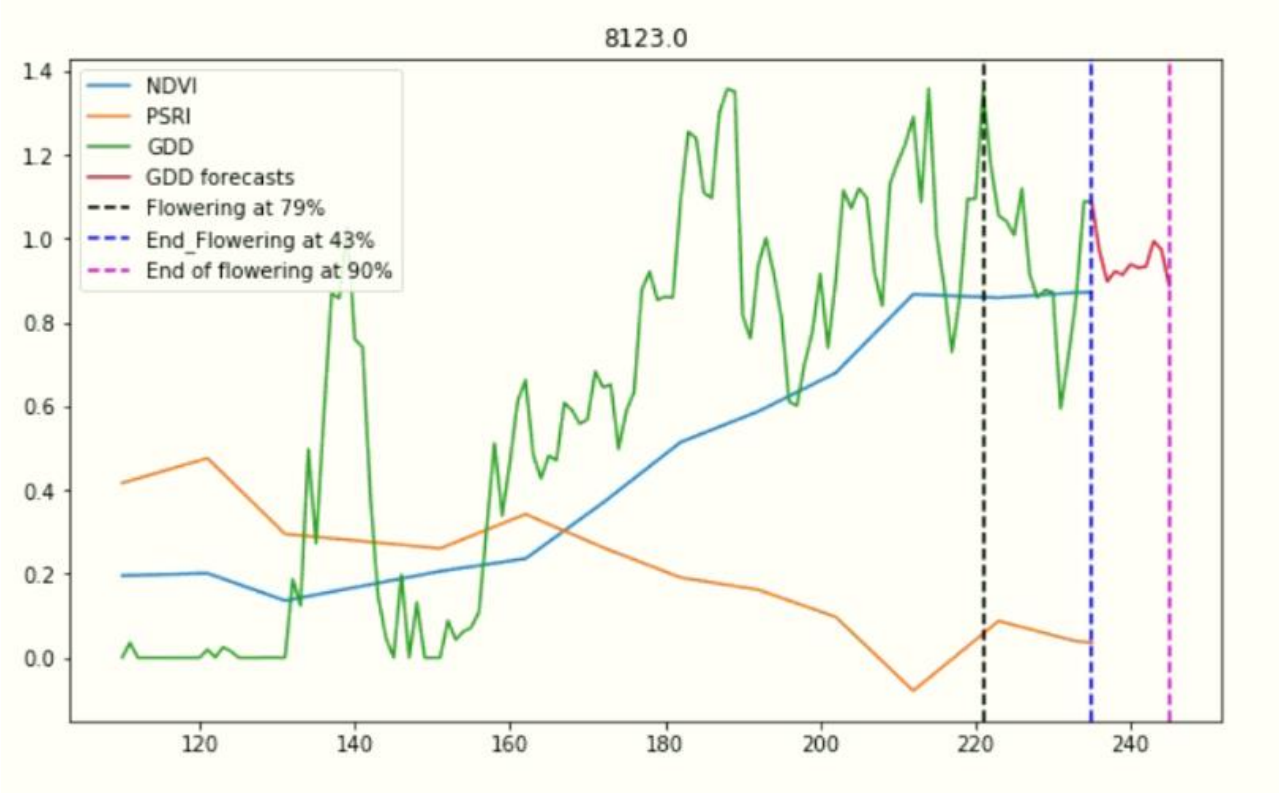
Parcel Information – Phenology estimation and forecasting



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Farmers

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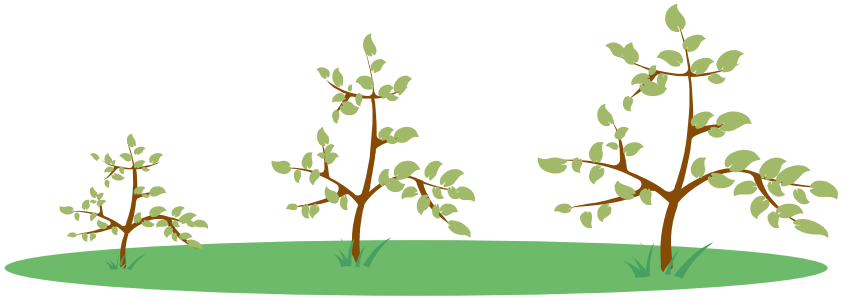
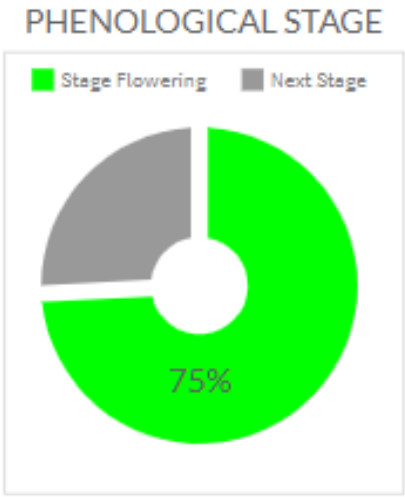


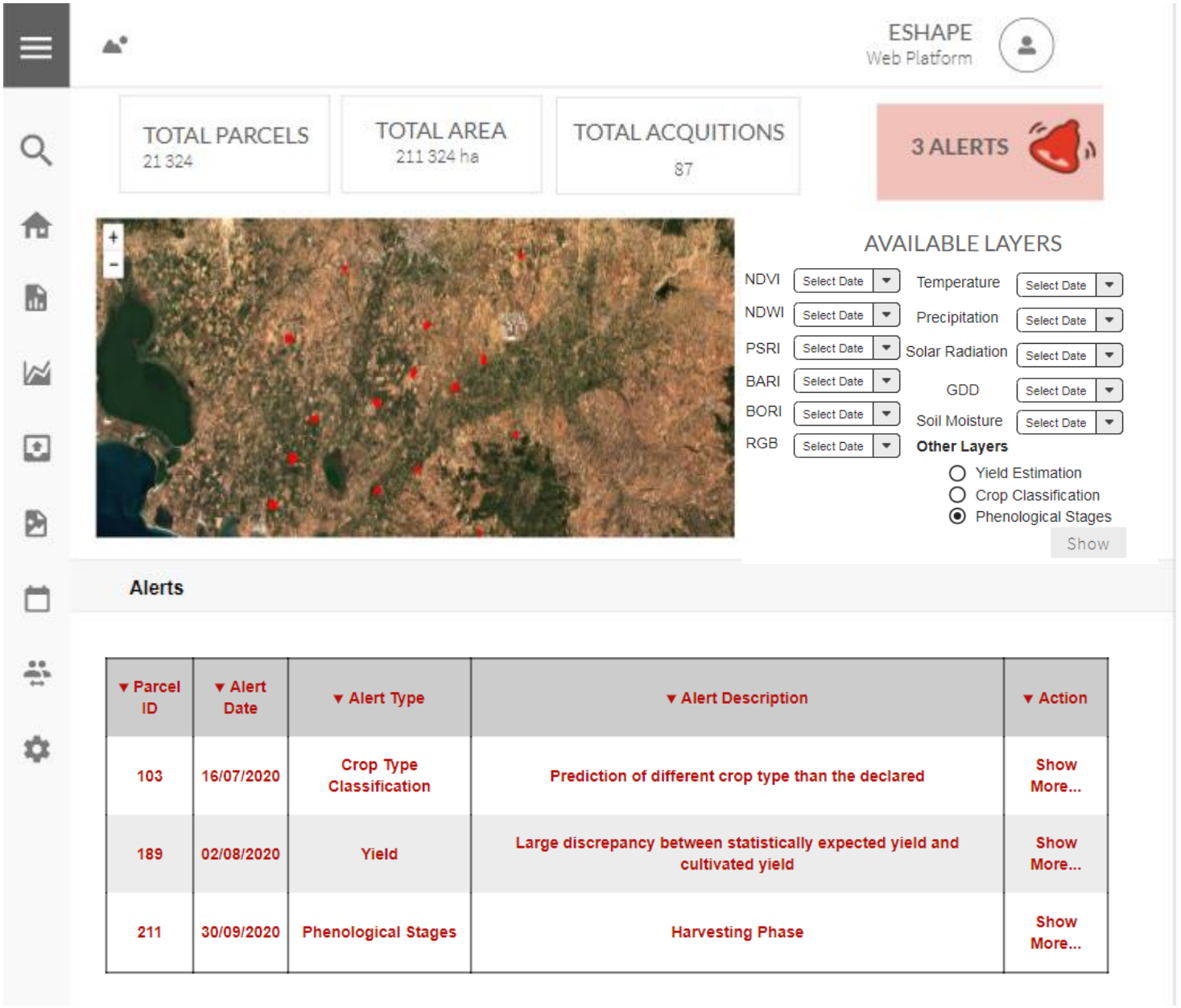
Parcel Information and statistical report at the parcel level

Parcel Information

Parcel ID	12890
Declared Type	Cotton
Predicted Type	Cotton
Prediction Confidence	High
Area (ha)	7.1
Mean Precipitation (mm)	13.8
Mean NDVI	03/01/20: 0.42, 08/01/20: 0.33 *more...*
Mean Temperature	18.9
Prediction of Yield (kg)	3187
Expected Yield (kg)	3102
Alert	No



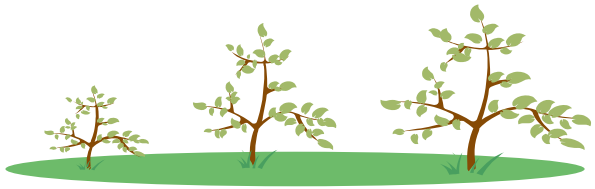
The Alert Mechanism



▼ Parcel ID	▼ Alert Date	▼ Alert Type	▼ Alert Description	▼ Action
103	16/07/2020	Crop Type Classification	Prediction of different crop type than the declared	Show More...
189	02/08/2020	Yield	Large discrepancy between statistically expected yield and cultivated yield	Show More...
211	30/09/2020	Phenological Stages	Harvesting Phase	Show More...

Take home message

- The Copernicus program offers a unique set of data that allows for providing large scale, timely and precise information for **evidence based decision making**
- Services are co-designed with the users – **rapid uptake, feedback for customization and fine-tuning, commercial sustainability** of services
- The methodological foundations of the services **are algorithmically general and technologically scalable** to allow for an extended user base
- The services are offered in **different formats that represent multiple levels of the value chain**, from plots and downloadble images and indices to actionable consultation



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