



A Transferable Sentinel-based Agriculture Monitoring Scheme

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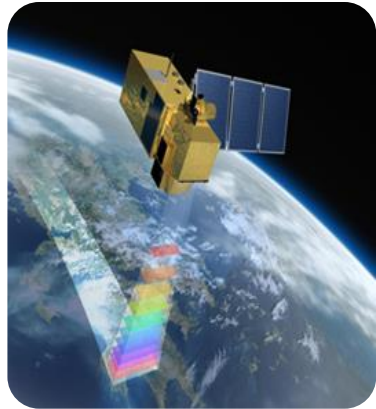
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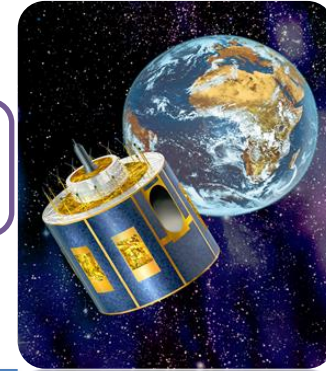
Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing (IAASARS)
National Observatory of Athens (NOA)



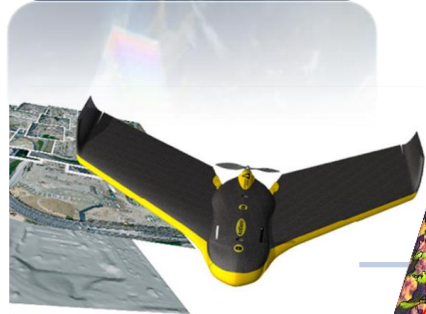
Monitoring Systems



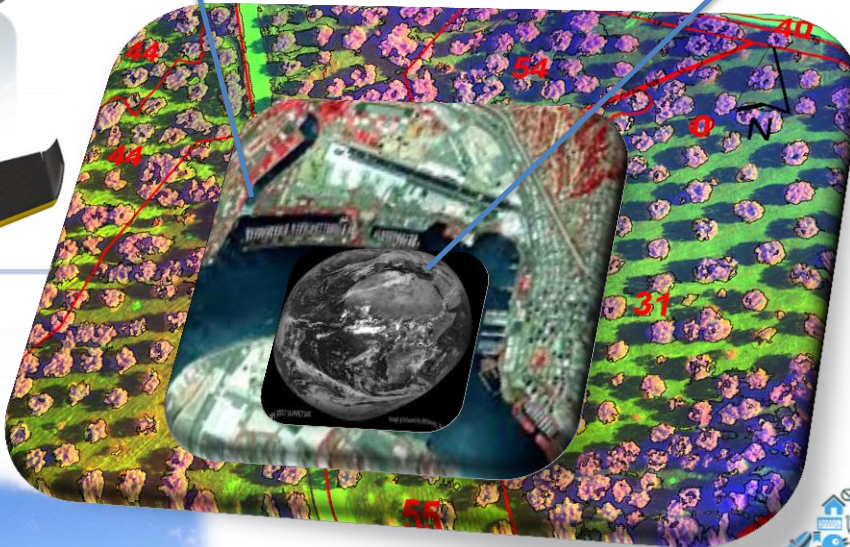
Polar orbit satellites
X-/L-band Station
Sentinel
Mirror Site



Geostationary orbit satellites
MSG Seviri



UAVs



in-situ

In-situ platforms & networks



Hellenic National Sentinel Data Mirror Site / ESA-NOA Agreement



COPERNICUS AND ITS SENTINELS

European Earth Observation Programme Copernicus: observing our planet for a safer world

The infographic details the following Sentinel missions:

- SENTINEL-1:** Dual-polarization synthetic aperture radar (SAR) imaging satellite for land and ocean monitoring.
- SENTINEL-2:** Medium-resolution optical satellite for observation of land, vegetation, and water.
- SENTINEL-3:** Measures sea surface temperature, soil moisture, and land surface temperature.
- SENTINEL-5P:** Global observation of key atmospheric constituents.
- SENTINEL-4:** Provides hourly updates on air quality.
- SENTINEL-5:** Observation of quality and color of water.
- SENTINEL-6:** Observes changes in sea surface height.

Sentinel Image Processing Toolbox Overview and Description Text

View the Sentinel Processing Toolbox User Manual



Sentinel-1

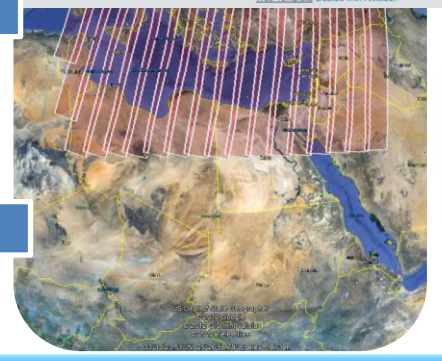


Sentinel-2

NOA Hellenic National Sentinel Data Mirror Site Team
 NOA Official: Prof. Kanaris C. Tsiganos, President of NOA
 Scientific Coordinator: Dr. Haris Kontos, Research Director
 WebMaster: MSc. Theodoros Herekakis, Research Associate
 Development: MSc. Vassilis Tsironis, Research Associate
 Curator: Mr. Vaggelis Papakirikou, Research Associate

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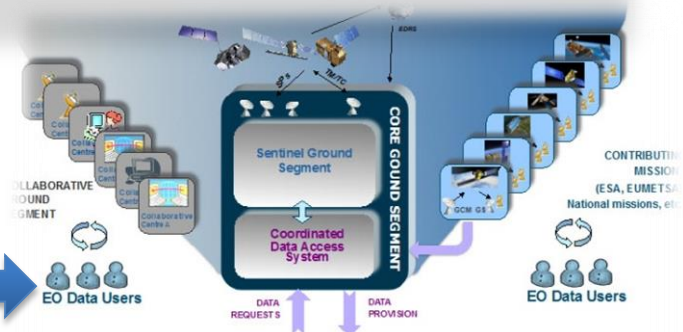
National Observatory of Athens



Sentinel-3



Sentinel-5p



Distributes 150-200 GB/day
Operates non-stop 24/7
Powered by the GRNET/GEANT
Network Speed 150-200 Mbps
250 Users in South-East Europe

<http://sentinels.space.noa.gr>

RECAP Project

- Contributes to the simplification of the CAP for all stakeholders enhancing the transparency and efficiency of the monitoring process



Developed improved **remote monitoring** of CAP CC and Greening rules to assist the Paying Agencies (targeted on-field inspections)



Offer farmers a tool supporting them to better **comply** with CAP CC and Greening rules (personalized guidance)



Enable agricultural consultants to **access data** in the platform to develop their own services within it (application reuse)



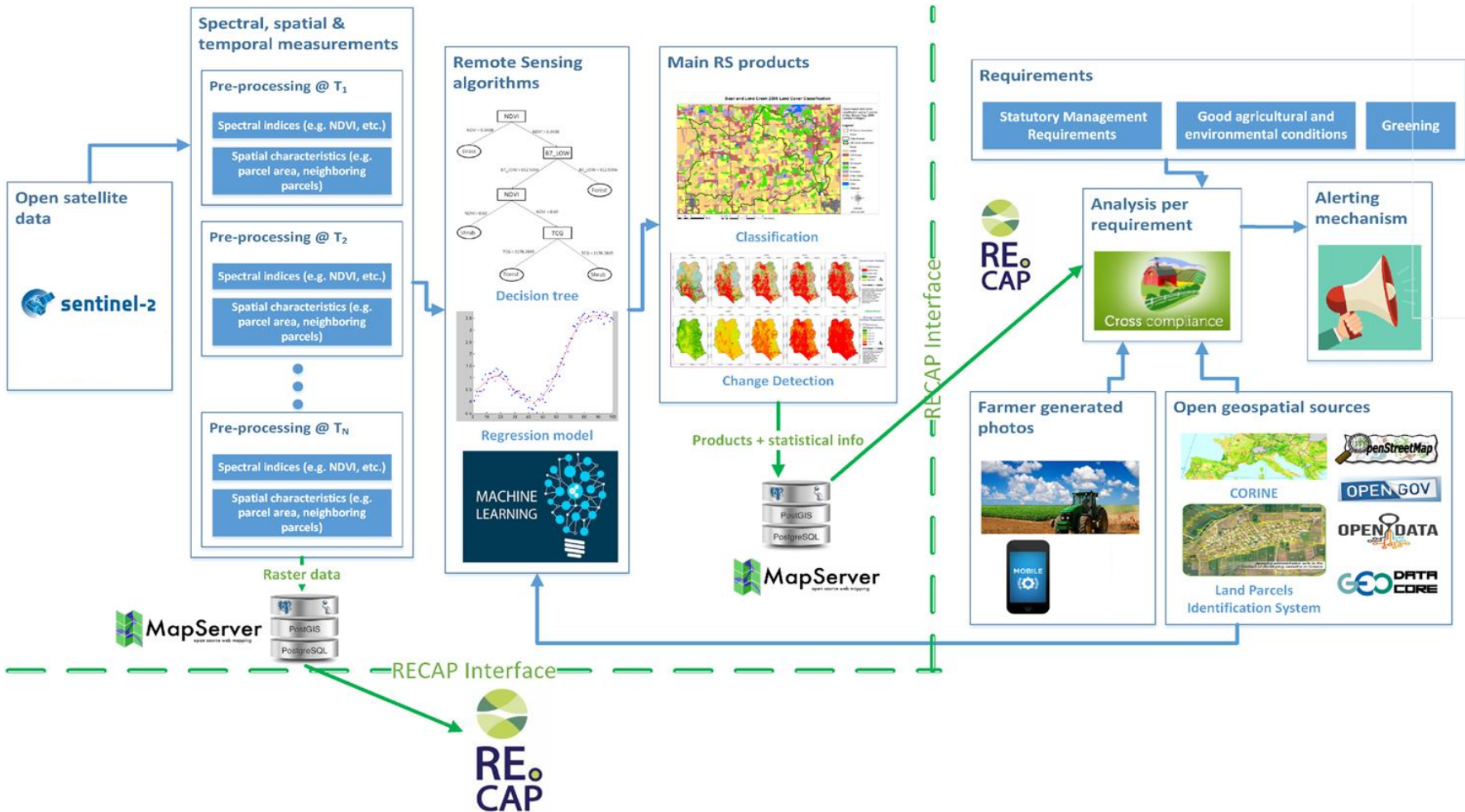
EO in RECAP

- **The issue:** Effective decision making on farmers' compliance to CAP CC and Greening rules

Soil/Carbon: Soil Organic matter	Crop residue burning restrictions (may not burn crop residues unless there is a plant health reason)	GAEC 6
Biodiversity: Crop Diversity	Diversification of crops	Greening 1
Soil/Carbon: Grassland	Maintenance of permanent grassland	Greening 2
Soil/Carbon: Soil cover	Maintain soil cover (unless agronomic justification)	GAEC4
Water: Nitrates	Area treated with N	SMR1
Water: Abstraction	Permits required for irrigation	GAEC2
Biodiversity: Habitats	Maintenance of semi-natural habitats	SMR2, SMR3
Landscape Features	Protecting scheduled ancient monuments	GAEC7
Water: Nitrates	Must inform of new slurry installation construction	SMR1
Water: Buffer Strips	Location of watercourses	GAEC1

- **The opportunity:** The availability of suitable and freely available data (Sentinels)
- **The solution:** Automated, transferable, robust classification & modeling tools based on multi-temporal, multi-spectral data

NOA in RECAP



Achievements in a nutshell

By collecting and analysing datasets from Paying Agencies
(**RECAP partners**):

1. Developed a novel, parcel-based, machine learning, processing workflow for **classifying crops** using S2 (Crop Diversification)
2. Developed a methodology based on the Revised Universal Soil Loss Equation (RUSLE) for the **assessment of water pollution** at parcel level (Statutory Management Requirements)
3. Customized an in-house burnt scar mapping algorithm for **detecting burnt parcels** with S2 (Stubble Burning)

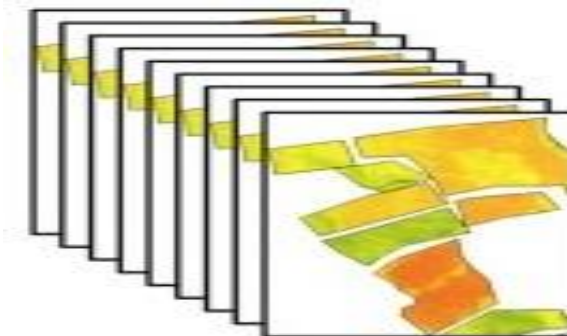
Crop Identification

Multi-temporal approach

- Sentinel-2 MSI imagery **time-series**
- Capture **crop development stages**

Parcel-based image analysis

- Segmentation using the LPIS data
- Pixel values within a parcel object are averaged



Feature space

1. RGB, NIR, Red-Edge and SWIR bands of all S2 scenes
2. Vegetation Indices (**NDVI, PSRI, NDWI, SAVI**) are additionally computed and incorporated

Algorithms tested

- Weighted k-Nearest Neighbor
- Random Forest
- **Support Vector Machines (2nd order polynomial)**

Supervised Classification

SVM OA

91.59%

- More than **91% overall accuracy** for the 9 main crop classes in the AOI
- Use of free and open data: **transferability**
- Geographically independent and potentially **scalable**
- Some of the crop types have very **similar spectral signatures** (e.g. wheat, barley and oats)
- Crop types of **inconsistent vegetation cover** (e.g. shrub grass) could provide broad and fluctuating spectral signatures

Crop Type	SVM PA	SVM UA
Soft Wheat	95.52	92.14
Corn	92.31	93.51
Barley	92.34	91.22
Oats	80.43	89.08
Sunflower	83.23	95.21
Rapeseed	89.22	95.94
Broad Beans	89.96	93.85
Shrub Grass	75.45	83.44
Vineyards	79.80	82.69

Impact of Sentinels

- A Landsat 8 equivalent scheme was implemented and compared to the Sentinel 2 scenario
- Comparisons were made in terms of **spectral, spatial and temporal** characteristics.
- Sentinel 2 scheme performance proved to dominate with respect to all three sensor characteristics¹.
- Sentinel's 10 m and 20 m spatial resolution offered satisfactory results even for parcels smaller than **0.5 ha**
- Sentinel 2's 5 day revisit time ensures the construction of **informative image time series** even in heavily clouded regions

¹ Scalable Parcel-Based Crop Identification Scheme Using Sentinel-2 Data Time-Series for the Monitoring of the Common Agricultural Policy. doi: <https://doi.org/10.3390/rs10060911>

Future work

- Currently the scheme is being tested on 5 diverse **pilot scenarios**
- Feedback from validated compliance statistics would allow the better tuning of methods
- Ancillary **user-generated data** (georeferenced and dated photos) will be incorporated to assist in the decision making

Conclusions

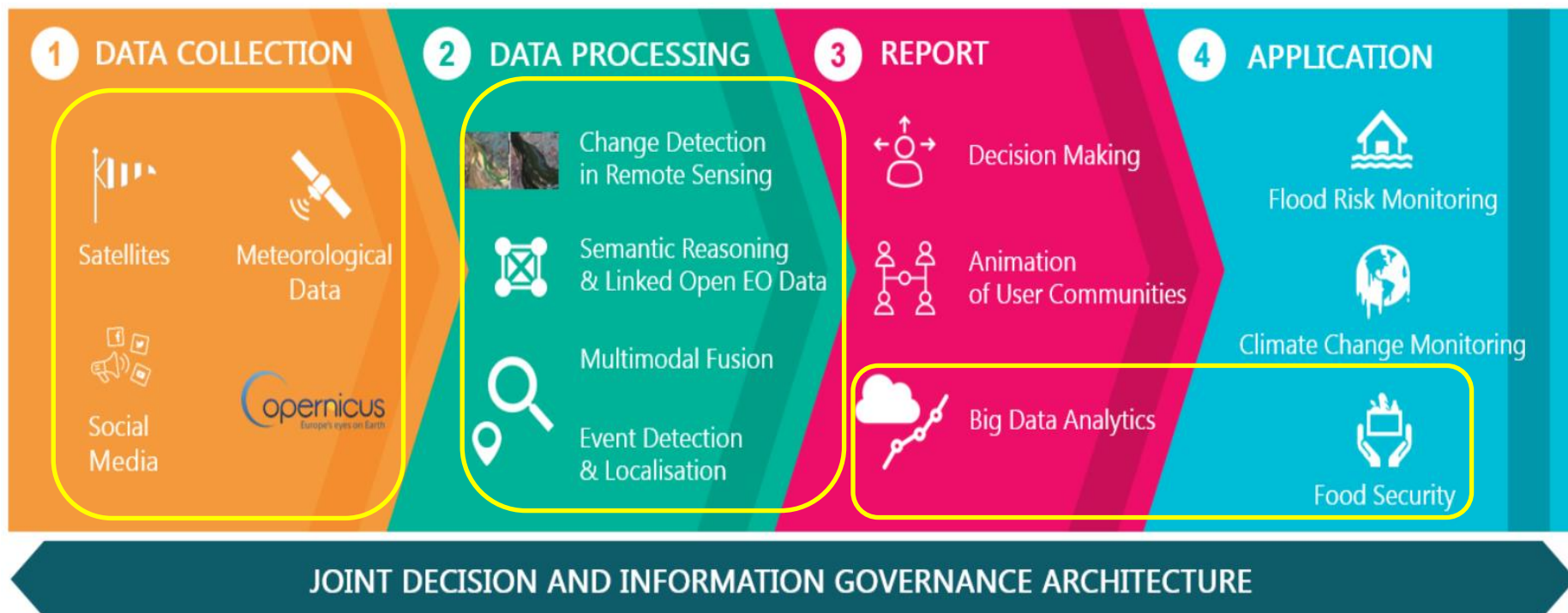
The Remote Sensing Component of the RECAP platform provides **automated** workflows for:

1. **Crop identification**
2. Burnt area mapping
3. Polluted water runoff risk assessment

System design & implementation characteristics

- ➔ On demand
- ➔ Time and cost efficient
- ➔ Geographic transferability
- ➔ Scalability to higher data dimensions (Big Data)

EOPEN project





38th Annual EARSeL Symposium 9-12 July 2018
Earth Observation Supporting Sustainability Research
Chania, Crete, Greece



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www.beyond-eocenter.eu



Thank you

Any questions?