A Transferable Sentinel-based Agriculture Monitoring Scheme

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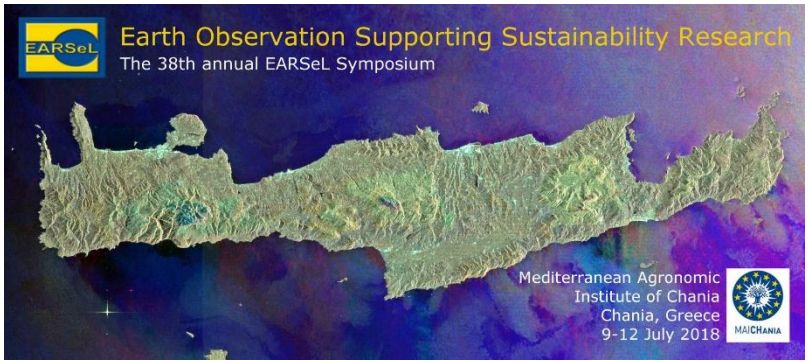

38th Annual EARSeL Symposium 9-12 July 2018
Earth Observation Supporting Sustainability Research
Chania, Crete, Greece

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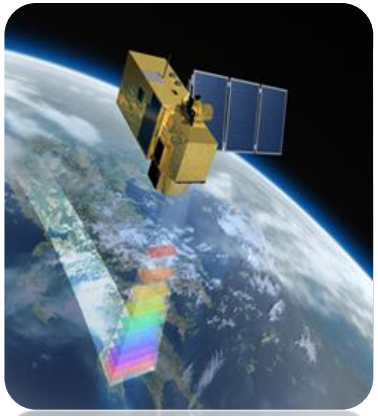
Monitoring Systems

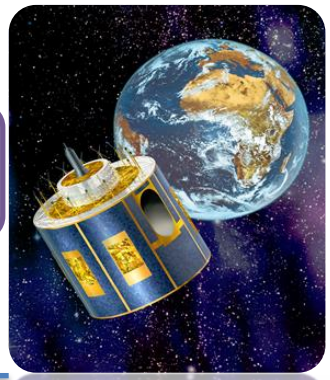


Polar orbit satellites

X-/L-band Station

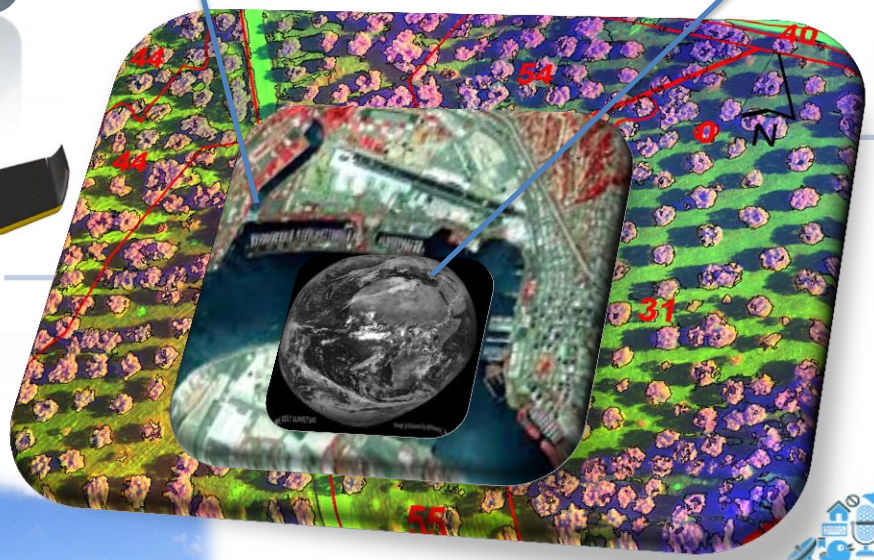
Sentinel Mirror Site

DATA → **ANALYSIS** → **INFORMATION**



Geostationary orbit satellites

MSG Seviri



in-situ

In-situ platforms & networks

UAVs

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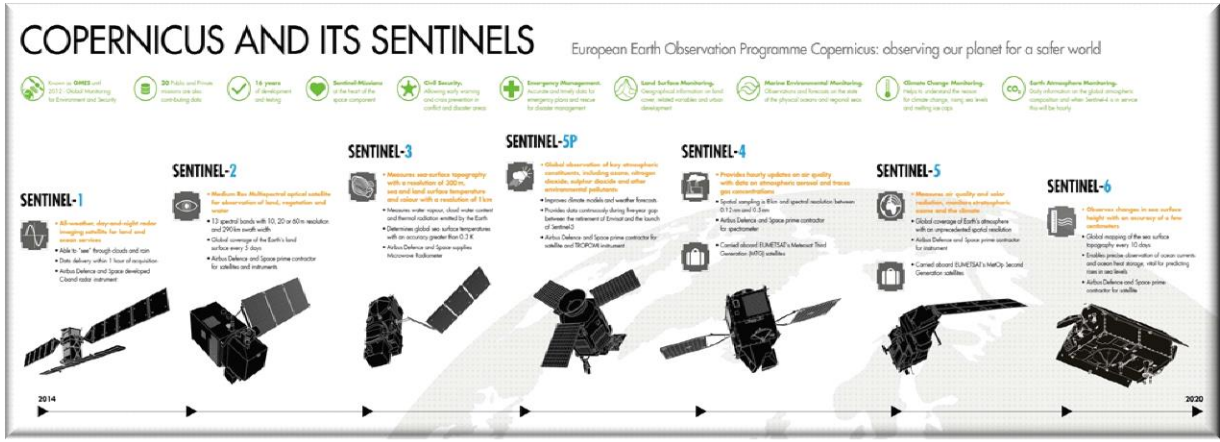
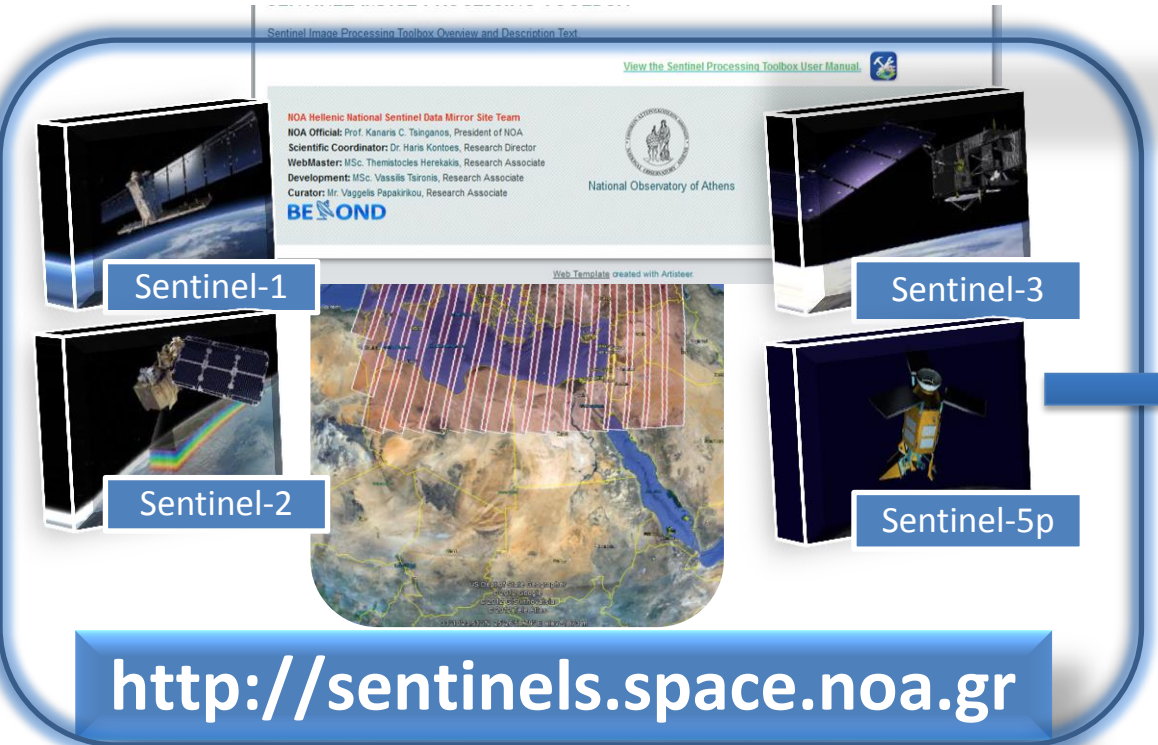
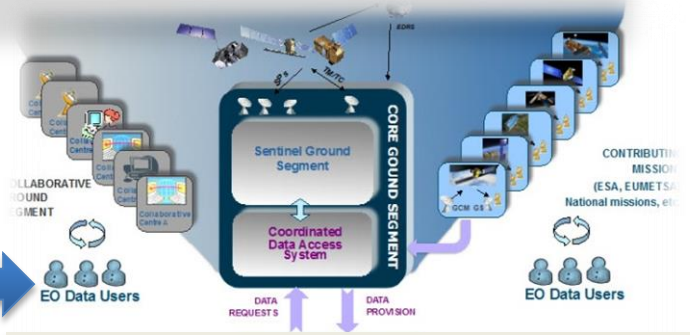
Hellenic National Sentinel Data Mirror Site / ESA-NOA Agreement

BEYOND SERVES
opernicus
The European Earth Observation Programme





http://sentinels.space.noa.gr



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

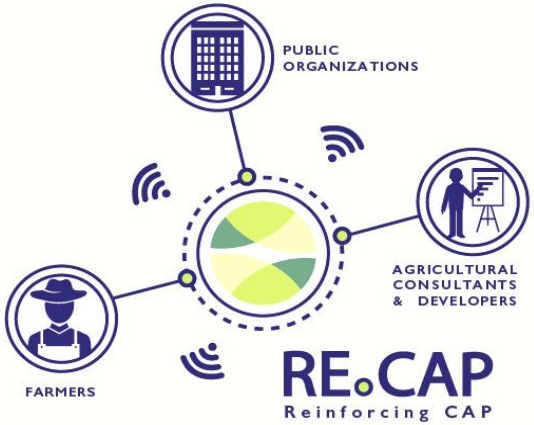
RECAP Project

- 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)



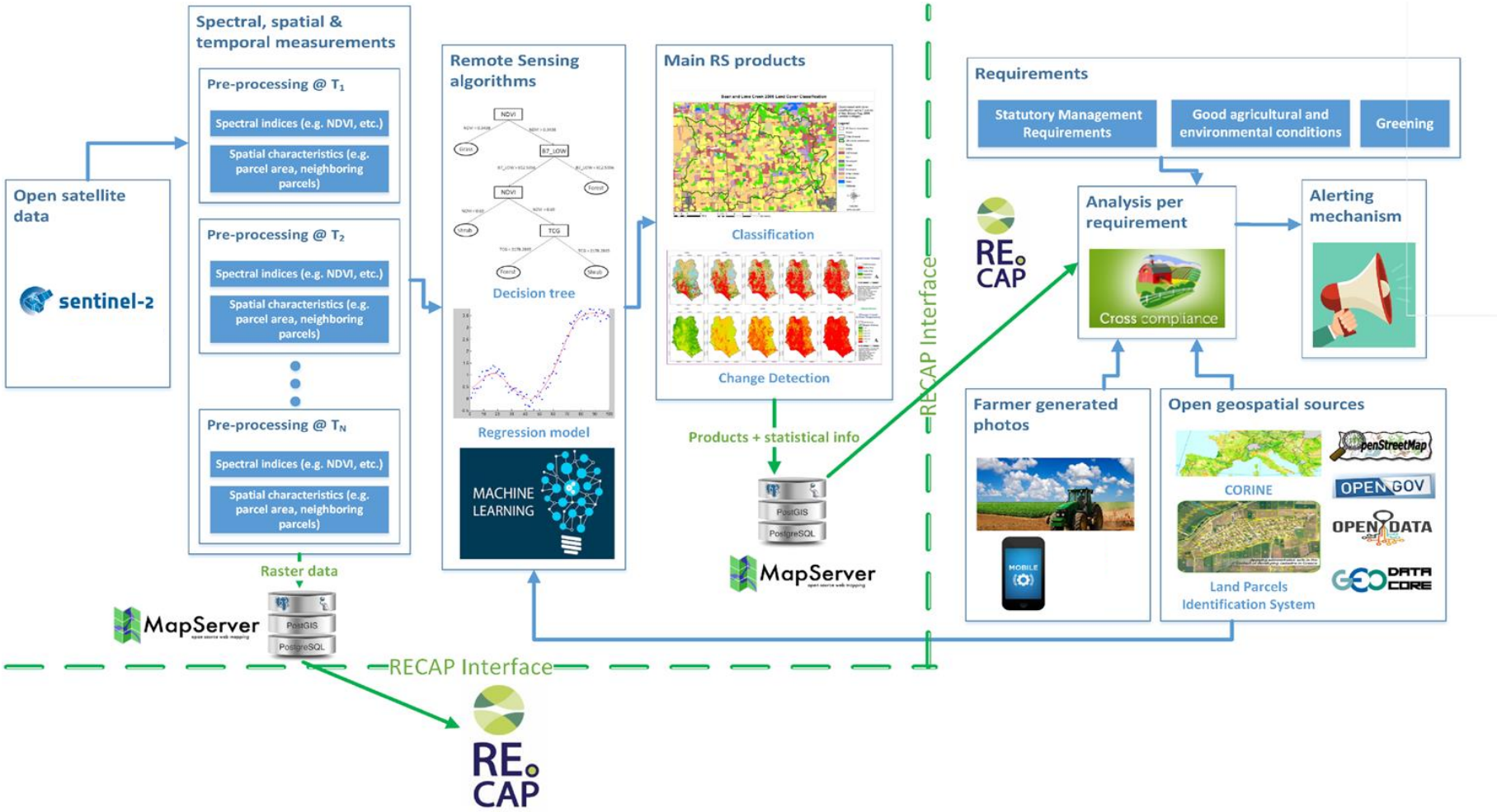
EO in RECAP

- **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

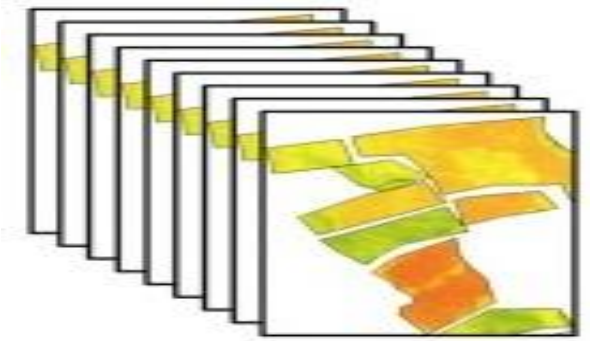

Open satellite data
sentinel-2
Spectral, spatial & temporal measurements
Pre-processing @ T1
Spectral indices (e.g. NDVI, etc.)
Spatial characteristics (e.g. parcel area, neighboring parcels)
Pre-processing @ T2
Spectral indices (e.g. NDVI, etc.)
Spatial characteristics (e.g. parcel area, neighboring parcels)
Pre-processing @ TN
Spectral indices (e.g. NDVI, etc.)
Spatial characteristics (e.g. parcel area, neighboring parcels)
Raster data
MapServer
PostGIS
PostgreSQL
RECAP Interface
RE CAP
Remote Sensing algorithms
Decision tree
Regression model
MACHINE LEARNING
Main RS products
Classification
Change Detection
Products + statistical info
MapServer
PostGIS
PostgreSQL
RECAP Interface
Requirements
Statutory Management Requirements
Good agricultural and environmental conditions
Greening
RE CAP
Analysis per requirement
Cross compliance
Alerting mechanism
Farmer generated photos
MOBILE
Open geospatial sources
CORINE
OpenStreetMap
OPEN GOV
OPEN DATA
GEO DATA CORE
Land Parcels Identification System

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 characteristics[1].
- 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)

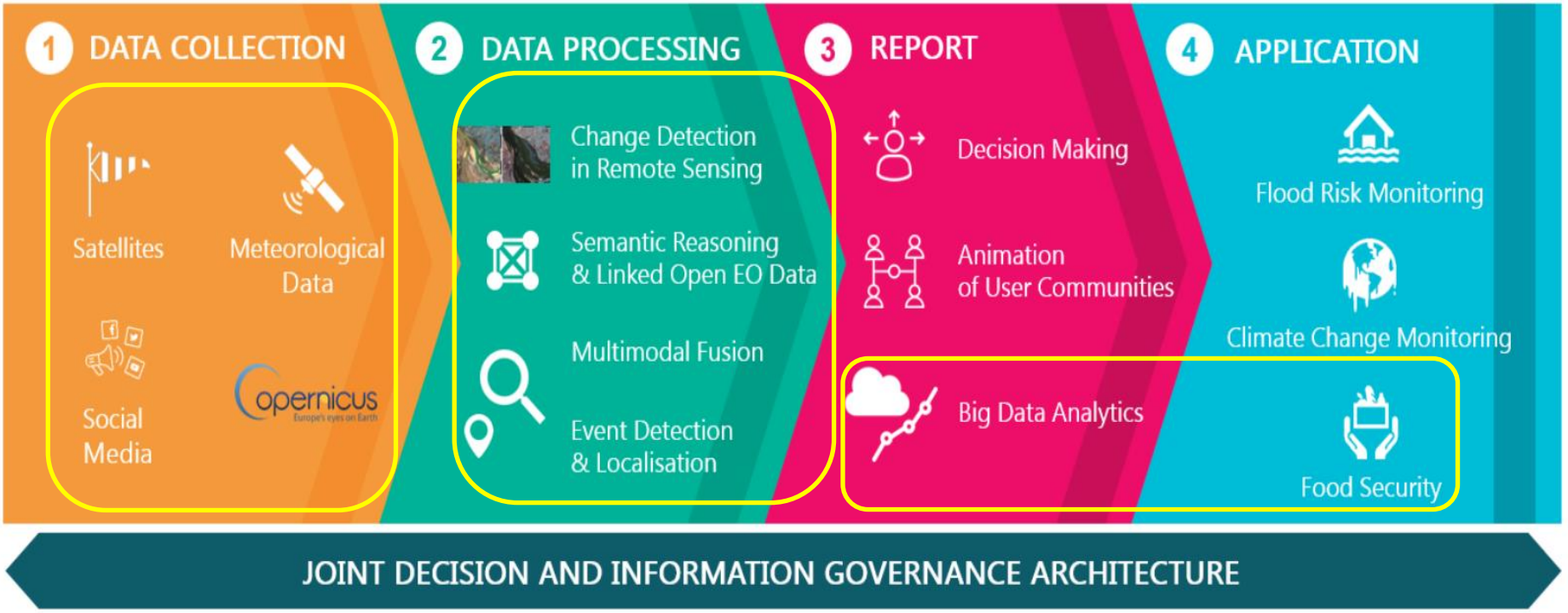
EOPEN project

EOPEN

GEOGLAM Global Agricultural Monitoring

Asia-RiCE Crop Estimation and Monitoring

2 ZERO HUNGER



Thank you

Any questions?