Automated remote sensing algorithms for CAP Cross Compliance and Greening obligations monitoring

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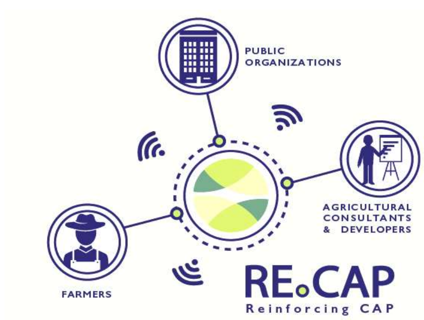
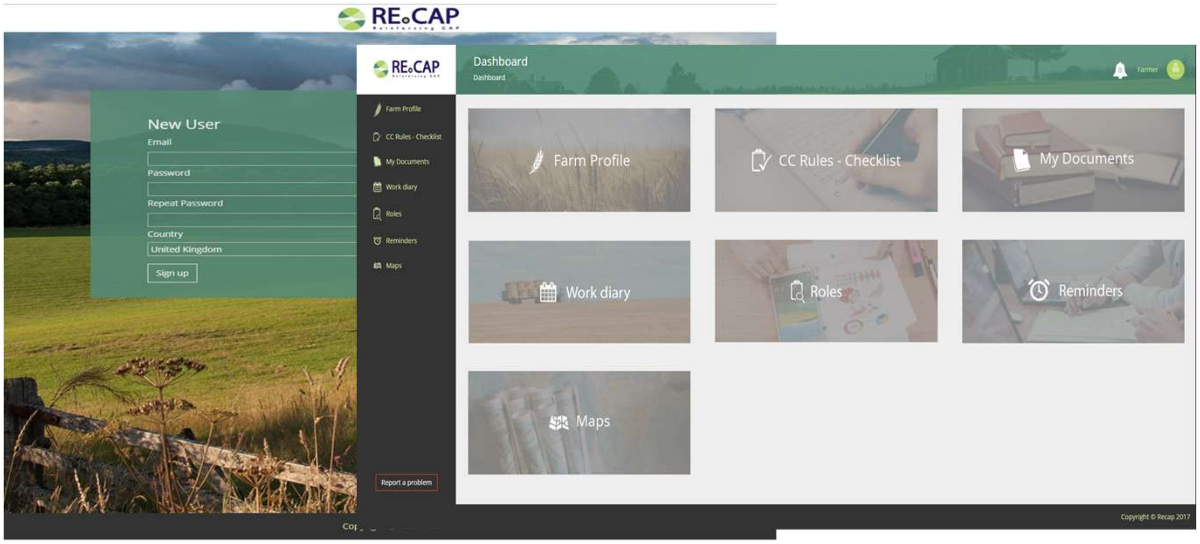
RECAP Project objectives

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

- Develop 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 **understand and comply** with the rules (personalized guidance)
- Enable agricultural consultants to **access data** in the platform to develop their own services within it (application reuse)



The RECAP Platform



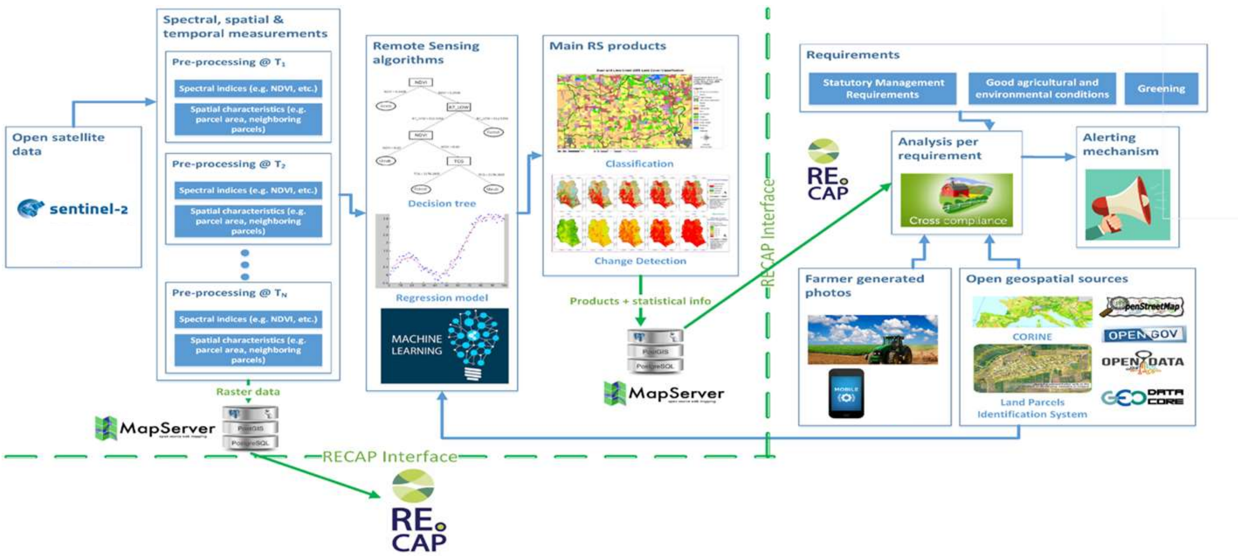
Remote Sensing in RECAP

- **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

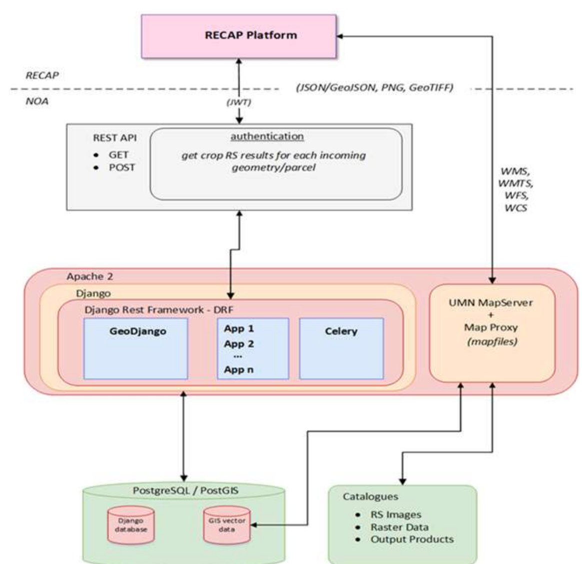
NOA in RECAP



RS Component Architecture

Employed technologies

- Well-established
- Open-source
- Modular
- Extendable
- Enable re-usable applications



System Functionalities

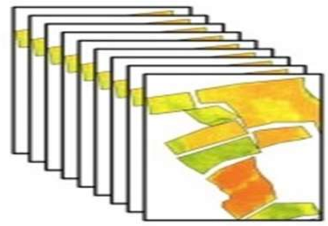
- **logging mechanism**
  - recording requests, process monitoring
- **tasking mechanism**
  - Sentinel 2 retrieval, image pre-processing, image classification, publishing RGB ortho-images and vectors
- **providing API and OGC services (mainly WMS)**
  - Post results for each parcel (i.e. vegetation indices, classification results, runoff risk etc.)
  - Serving static RGB satellite images

Achievements in nutshell

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

1. Developed a novel, parcel-based, machine learning, processing workflow for **classifying crops** using S2 (Greening 1 & 2)
2. Developed a methodology based on the Revised Universal Soil Loss Equation (RUSLE) for the **assessment of water pollution** at parcel level (SMR 1)
3. Customized an in-house levelset method for **detecting burnt parcels** with S2 (GAEC 6)

Crop Identification



Multi-temporal approach

- Sentinel-2 MSI imagery **time-series**
- Scenes, span throughout **crops' life cycle**
- Crop **phenology** is the discriminating information

Parcel-based image analysis

- Segmentation is performed based on LPIS data
- Pixel values, for all spectral bands and indices, within an object are averaged

Feature space

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

Algorithms tested

- Weighted k-Nearest Neighbor
- Bagged Trees (BT)
- **quadratic kernel Support Vector Machines (SVM)**

Supervised Classification

SVM OA	91.59%

- More than **91% overall accuracy** for the 9 main crop types in the AOI
- Use of free and open data : **transferability**
- Geographically independent and potentially **scalable**

Challenges

- Some crop types have similar time-series signatures (e.g. cereals, barley and oats)
- Crop types of **ambiguous vegetation cover** (e.g. shrub grass) are characterized by unspecific spectral behavior

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 OLI based scheme was implemented and compared to the Sentinel 2 MSI equivalent
- 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
- Sentinel's 10 m and 20 m spatial resolution offered high thematic accuracy even for smallholdings
- Sentinel 2's 5 day revisit time ensures the construction of meaningful image time series even in heavily clouded regions

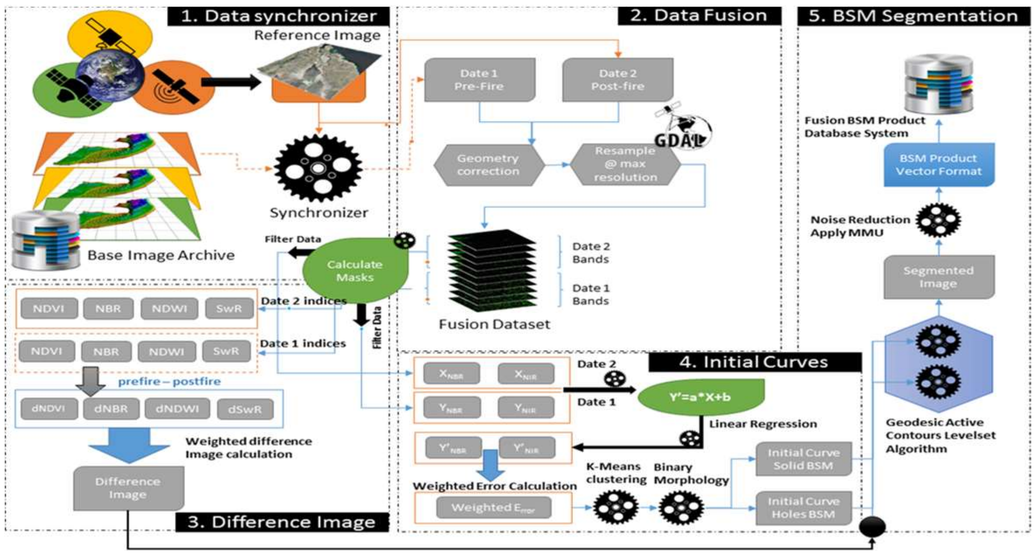
Polluted water runoff risk

- SMR 1: Reduce water pollution in Nitrate Vulnerable Zones (NVZs).
- The risk is based on parcels' **(1) RUSLE product and (2) Proximity to watercourse**

1. RUSLE refers to a nearly **static, freely available** product for **soil loss estimation** accounting for:
   a. slope/length of parcel
   b. rainfall-runoff erosivity,
   c. soil erodibility
   d. cover management (updated according to crop classification)
   e. support practices
2. Water proximity disregards parcels whose slope has **opposite orientation** (DEM-based) to the nearest watercourse

Combination of RUSLE and proximity provides **risk estimations** for each parcel

Burnt Scar Mapping



Future work

- Over the next nine months the platform will be tested on 5 diverse **pilot scenarios**
- Feedback from validated compliance statistics would allow the better tuning of methods
- Ancillary **user-generated data** (georeferenced and date-tagged 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)**