PERSONALISED PUBLIC SERVICES IN SUPPORT OF THE IMPLEMENTATION OF THE CAP

RECAP Session

"The value of Copernicus data for an automated monitoring of CAP "

INSPIRE Conference
19/09/2018

Haris Kontoes

Reinforcing CAP

The project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No. 693171.

CAP 2020+ Era

- From on-the-spot checks to monitoring
- Technology that makes things simpler
  - –Cloud automated process: simpler for farmer
  - –Use of Galileo Cloud: Simpler for farmers and administration
  - –Use of Big Data Automated Process: Simpler for administration
- Europe needs its rural areas, and European rural areas need this modernisation of the science, the technology and the willingness to help are there

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Remote Sensing in RECAP

- **The issue**: Effective decision making on farmers' compliance to CAP Cross Compliance 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

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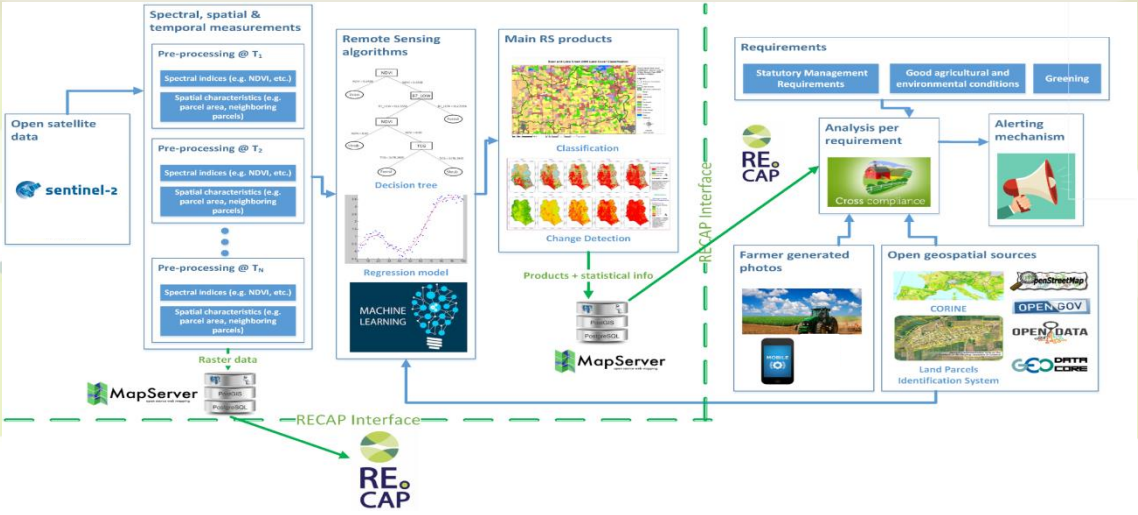
Overview of NOA's RS architecture in RECAP



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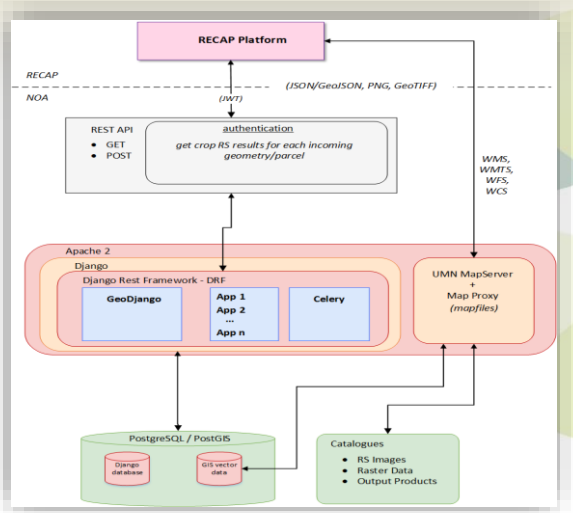
RS Component Architecture

Employed technologies

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



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Achievements in a 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 **risk assessment of water pollution** at parcel level (SMR 1)
3. Customized an in-house burnt scar mapping algorithm for **detecting stubble and residue burning** with S2 (GAEC 6)

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What EO input data to use?

- Open access and ease of data retrieval are key considerations in the RECAP project
- Landsat-8 and VHR imagery are the most common input data in relevant applications in the past decade
- The performance of both Landsat and VHR was tested and evaluated against the Sentinel-2 scenario

Input Data	Cost	Revisit	Accuracy	Scalability	Access	Coverage
Landsat-8 OLI	None	~ 15 days	High	High	Open	Global
Sentinel-2 MSI	None	~ 5 days	High	High	Open	Global
VHR	High	< 1 day	Medium	Low	Closed	Regional

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Non-EO data used

- Geospatial information of the crop parcels in the AOI (LPIS)
- The farmers' declarations on the cultivated crop type in the year of inspection
- Further higher-level grouping of crop types into crop families and season of cultivation
- Detailed hydrographic network

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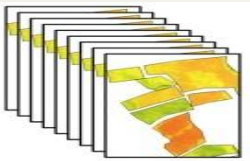
Crop identification – key characteristics

Multi-temporal approach

- Time-series of Sentinel-2 imagery
- Scenes cover the cultivation season
- **Phenology** is the discriminating information



Remote Sens. **2018**, *10*(6), 911; https://doi.org/10.3390/rs10060911 **Open Access** **Article**

Scalable Parcel-Based Crop Identification Scheme Using Sentinel-2 Data Time-Series for the Monitoring of the Common Agricultural Policy

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Received: 12 March 2018 / Revised: 6 June 2018 / Accepted: 7 June 2018 / Published: 8 June 2018

(This article belongs to the Special Issue High Resolution Image Time Series for Novel Agricultural Applications)

- **SVM Quadratic**

for all spectral bands and indices, within an object

, Red-Edge and **SWIR** bands of all scenes

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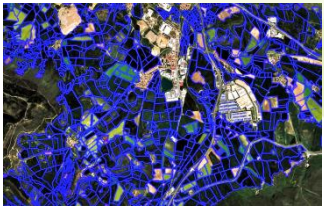

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Classification Approach

- The classification is done separately for three different levels of nomenclature
- 1st level: crop parcels are classified based on their season of cultivation, split into winter, summer and all-year crops
- 2nd level: crop parcels are classified based on the crop family they belong to, such as cereals, legumes, oilseed and trees
- 3rd level: the lowest level of classification is done on the declared cultivation types by the farmers

Season	⇒	Family	⇒	Crop Types
Winter		Cereals		Soft Wheat
Summer		Legumes		Broad Beans
All Year		Oilseed..		Corn...

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SVM Confusion Matrix

Kappa=0.90

True Class/ Predicted Class	Soft Wheat	Corn	Barley	Oats	Sunflower	Rapeseed	Broad Beans	Shrub grass	Vineyards	True Positive	False Positive
Soft Wheat	96%		3%	<1%	<1%	<1%	<1%	<1%	<1%	96%	4%
Corn		90%		<1%	5%	<1%	<1%	<1%	3%	90%	10%
Barley	5%		94%	<1%	<1%	<1%	<1%	<1%	<1%	94%	6%
Oats	8%		7%	83%	<1%	<1%	<1%	<1%	<1%	83%	17%
Sunflower	4%	1%	1%	<1%	89%	1%	1%		2%	89%	11%
Rapeseed	6%		1%	1%		90%	1%	<1%	<1%	90%	10%
Broad Beans	8%		<1%	<1%	<1%	1%	88%	2%		88%	12%
Shrub grass	9%		4%	<1%	<1%			86%		86%	14%
Vineyards	4%		3%	1%	1%			1%	90%	90%	10%

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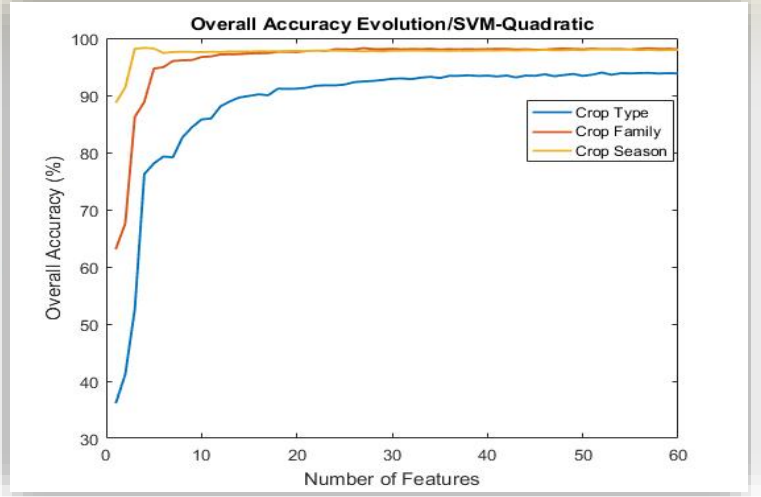
Accuracy evolution/SVM-Quadratic



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Why Sentinel-2?

McNemar Test	N_{ab}	N_{ba}	X^2	p-value	h
S2 (30m) / L8	192	671	265.86	~0	Yes
S2 / L8	146	723	383.11	~0	Yes
S2 SVM / RF	114	577	310.23	~0	Yes

- We used McNemar's test to evaluate the statistical significance in the classification accuracy between (i) the two classifiers (**SVM & RF**) in the Sentinel scenario and (ii) **Sentinel-Landsat pairs** in the SVM scenario.
- The usage of Sentinel-2 proves superior to the Landsat alternative for all three sensor characteristics (**spectral, temporal, spatial**)
- A combination of Landsat and Sentinel feature spaces marginally increases the overall accuracy and thus does not justify the higher complexity introduced.

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Discussion

Benefits

- **90% kappa coefficient accuracy** for the **9 major crop classes** involved in the AOI, explaining **90% of the total number of parcels**
- Use of free and open data : **transferable**
- Geographically independent and potentially **scalable**
- Exploit **trade-offs** depending on application

Limitations

- Sufficient number of parcels for each of the crop classes is required
- Some of the crop types, usually of the same crop family and/or of the same cultivation period have very similar spectral signatures (e.g. cereals, barley and oats)
- Crop types of ambiguous spectral behavior, such as shrub grass could provide broad and fluctuating spectral signatures
- Geographical variability of each crop type's spectral behavior => repeated runs in adequately small spatial extents

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Conclusions

- The Remote Sensing Component of the RECAP platform provides **automated** workflows for the classification and burnt area mapping of the agricultural scenery, along with the polluted water runoff risk assessment
- System design & implementation characteristics
  - ⇒ **On demand**
  - ⇒ **Time and cost efficient**
  - ⇒ **Geographic transferability**
  - ⇒ **Scalability to higher data dimensions (Big Data)**
- **Considerations**: cloud coverage, truthfulness of declarations, crop type nomenclature

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Timely information for targeted on-the-spot inspections

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Classification confidence

- Introduction of the traffic light system for smart sampling based on the posterior probability confidence of the classification decision

Percentage of parcels	Confidence	Accuracy
85%	Green	94%
6%	Yellow	71%
4%	Red	58%
5%	**Unreliable**	50%
	Overall accuracy	88%
Total number of parcels	12447	

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Spanish pilot 2018

Crop type	Green	Yellow	Red	# parcels
Soft weat	87%	5%	4%	3962
Corn	76%	10%	6%	173
Barley	87%	5%	4%	2584
Oats	79%	7%	6%	739
Sunflower	76%	7%	5%	186
Rapeseed	90%	4%	3%	492
Broad Beans	63%	11%	11%	128
Shrub Grass	58%	13%	12%	181
Vineyards	54%	15%	14%	140
Cherry trees	67%	7%	9%	124

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A Smart Sampling

PAs can pinpoint cases of potential breaches of compliance and target their inspections via being provided with:

1. Parcels classified with **high confidence** to **different** crop types than the declared one – potential case of wrongly declared parcel
2. Parcels classified with **medium confidence** to **different** crop types than the declared one – potential case of both wrongly declared and wrongly classified parcel
3. Parcels classified with **high confidence** to the **same** crop type as the declared one – no particular interest

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High Confidence – Different Declaration

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Thank you for your attention!

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