Sen4CAP
Sentinels for CAP monitoring approach

Benjamin Koetz & Sen4CAP team
European Space Agency, Earth Observation Directorate
Sentinels for Agricultural Dynamics

Majority of Europe >2 day revisit

Sentinel-1

S-1A & -1B (July-Sept 2018)

Majority of Europe >3 day revisit

Sentinel-2

S-2A & -2B (July-Sept 2018)
Dear Mr Aschbacher,

Both ESA and the European Commission have an interest in promoting and supporting the development of Earth Observation (EO) use and related capacity in Agriculture. We have taken great interest in the results of the CzechAgri study that was jointly initiated in December 2015 by ESA, DG JRC and SZIF (Czech Paying Agency) and successfully implemented thanks to ESA funding and a technical steering involving DG AGRI.

Following these promising results, it would be extremely useful to further explore—in close cooperation with the European Commission—the capabilities of the Copernicus Sentinels in view of the current works on the modernisation and simplification of the CAP and the opportunities of EO from space for supporting the Integrated Administration and Control System (IACS). As you may know, technical solutions to improve and to make the IACS more cost efficient are high on the political agenda. A promising way forward is offered by the important potential of Sentinel/Copernicus for administration and control purposes, i.e. in a broader perspective than the current on-the-spot controls using remote sensing. Indeed, the ambition for the next programming period is greater, we also want the IACS to be a key tool in the delivery of enhanced environmental services and public goods.

With this letter, we acknowledge and welcome ESA’s readiness to continue this effort by conducting two or three follow-up pilot studies to the CzechAgri project in preparation of the CAP 2020 reform together with the main stakeholders (DG AGRI, DG GROW and DG JRC) and the national Paying Agencies.

1st Evidence March 2018
Checks by Monitoring May 2018
1st Demonstration Results November 2018
Sen4CAP Objectives:

- **Provide evidence** how Sentinel derived information can support the modernization and simplification of the CAP in the post 2020 timeframe
- **Provide validated algorithms, products, workflows** and **best practices** for agriculture monitoring relevant for the management of the CAP
Sen4CAP – Expertise, Technology & Collaboration

Paying Agencies & Farmers

DG-Agri, JRC, DG-Grow

Steering Committee

Open Source

Cloud Technology (DIAS)

Continuous Monitoring

Validated Performance

National Demonstration

Innovative Practices

CAP2020 Reform
Use case

- Crop diversification
- Permanent grassland identification
- EFA-Land lying fallow
- EFA-Catch crops
- EFA-Nitrogen-fixing crops
- Land abandonment
- Interactive visualization
- LPIS update
- Claimless system
Sentinel-based markers for CAP Monitoring

- Crop type mapping
- Vegetation growing indicator
- Grassland mowing detection
- Agricultural practices monitoring

Crop type information & vegetation growing indicators

Number of detected mowing events

Autumn barley

FULL USE OF SENTINEL TIME SERIES
Parcel Level Implementation – New Approach

- 5-m inner buffer
- Parcels whose centroid is inside

Czech Republic: 97% Parcels, 0% Area
Netherlands: 91% Parcels, 0% Area
Lithuania: 94% Parcels, 0% Area

Italy: 64% Parcels, 16% Area
Romania: 11% Parcels, 2% Area

*based on crop diversification use case
Monitoring of Agricultural Practices

- IACS use case: Ecological Focal Area compliancy (5% area for farms >15ha)
  - based on S1&2 time series – 5 markers tracing crop activities

Output (per parcel):
- Harvest detection
- Harvest week
- Catch crop detection
- Confidence level for compliancy

Catch crop, Czech Republic

Winter Catch Crop – Visual check

Harvest
Catch Crop period
HARVEST CATCH CROP PERIOD

WINTER WHEAT

COMPLIANT

SPRING WHEAT

NON COMPLIANT

COMPLIANT
Crop type mapping for crop diversification monitoring
Netherlands - National Scale

Observed crop type (2017)

95% of parcels

Full Resolution Visualization Online:
http://www.esa.int/spaceinimages/Images/2018/05/Crop_map
Crop type mapping for crop diversification monitoring
Castilla y Leon – « National Scale »

Observed crop type map (2018)

95% of total area

Castilla y Leon - 2018
OA = 84%
Crop type mapping for crop diversification monitoring
Castilla y Leon – « National Scale »

Observed crop type map (2018)
Agreement indicator at the parcel level
Compliance indicator at the holding level

- Green: Compliant or not required
- Grey: Not assessed
- Light green: High-conf agreement
- Light yellow: Average-conf agreement
- Light orange: Weak-conf agreement
- Dark red: Disagreement
Permanent Grassland Use Case (Czech Republic)

Grassland mowing product consists in the detection of mowing events occurred on grassland parcels during the period of interest and in the assessment of their compliancy, according to the national regulations.

National regulations
At least 1 mowing or grazing within 31st July

Compliancy level

0: Not assessed
1: Assessed and compliant because a mowing occurred in the reference period
2: Assessed and not compliant because no mowing occurred in the reference period
2018 – Status of production & parcel analysis

- Evaluation of **impact of parcel size and shape** number of parcels assessed
- Approach adopted: all parcels **having at least 1 pixel whose centroid falls inside 5 meters buffer**
- Performance – preliminary 2018 results for NLD show >80% accuracy (2017 accuracy: NLD 88%, CZE 89%)
- **High heterogeneity** of grassland phenology between different climate zones (e.g. NDL - ESP)

<table>
<thead>
<tr>
<th>Country</th>
<th>Area Of Interest</th>
<th>EO input up to now</th>
<th>Total Parcels (n°)</th>
<th>Parcels not assessed (%)</th>
<th>Mean parcel area not assessed (ha)</th>
<th>Total AOI area not assessed (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NLD*</td>
<td>100 % country</td>
<td>S2</td>
<td>404.975</td>
<td>0.3 %</td>
<td>0.8 ha</td>
<td>0.1 %</td>
</tr>
<tr>
<td>CZE*</td>
<td>100 % country</td>
<td>S2</td>
<td>323.269</td>
<td>0.03 %</td>
<td>1.3 ha</td>
<td>0.01 %</td>
</tr>
<tr>
<td>LTU</td>
<td>100 % country</td>
<td>S2, S1</td>
<td>402.160</td>
<td>0.1 %</td>
<td>0.9 ha</td>
<td>0.05 %</td>
</tr>
<tr>
<td>ITA*</td>
<td>100 % of the AOI (5 Regions)</td>
<td>S2</td>
<td>277.603</td>
<td>17 %</td>
<td>0.01 ha</td>
<td>0.2 %</td>
</tr>
<tr>
<td>ESP</td>
<td>100 % of the AOI (Castilla Y Leon)</td>
<td>in progress</td>
<td>1.273.693</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROU</td>
<td>100 % country</td>
<td>in progress</td>
<td>2.080.995</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Statistics on NLD, CZE and ITA are based on products generated only on the basis of S2 data. They could be slightly overestimated.*
Preliminary 2018 results
Grassland mowing detection - Lithuannia

- GPŽ, Pasture or meadow, perennial grass up to 5 years
- DGP, Perennial pastures or meadows 5 years and more
- GPA, Pasture or meadow, perennial grass up to 5 years, renewed in the current year
- EPT, Extensive meadows grazing with livestock
- NPT, Natural and semi-natural meadows
- SPT, Specific meadows
- 5PT-2, Extensive management of wetlands (direct payments are paid)

Based on S1 and S2 (only NDVI)
Final version will also use S2 LAI and FAPAR
Design of Sen4CAP processing system

Machine Learning & Open Source
Towards uptake by Paying Agencies

Integration of S1 & S2 images, EO products & markers in PA’s environment

WMS providing RGB imagery and simple indicators

- Easily integrated in PAs environment
- S1, S2 & L8 images
- Planet imagery visualization
- Vegetation Indicators (NDVI, LAI, Fcover, FAPAR)
- Time filtering
- Configurable visualization
- Reprojection to local coordinate systems
- Customizable by country
Visualisation tool – Compliancy at parcel/farm level
Validation – performance across EU heterogeneity

- **In-situ data sets** shared by Paying Agencies
  - LPIS/GSAA datasets, subsidy applications, physical inspections, CwRS
- **Dedicated In-situ data sets**
  - farmer interviews – 250 to 500 fields surveyed by practices & country
  - Visual analysis of Planet time series (250-500 fields by practices & country)
- **Sampling** **heterogeneous EU agricultural landscape**:
  - LPIS types: Cadastral (IT, ES), Physical Block (NL, LI, RO), Farmers Block (CZ)
  - Field sizes: Minimum: RO & IT 72-85% < 1ha, Maximum: CZ 66% > 1ha
  - Landscape & climate: wide geographical range
- **Validation results 2017** (2018 on-going):
  - crop type (OA): CZ 93%, ES 83%, IT 66%, LI 87%, NDL 96%, RO 71%
  - grassland (OA): CZ 89%, NDL 88%
Visual Validation - Grassland Mowing

First Mowing Date 1: 07.05.2018

3 May

4 May

5 May

8 May
### From National to European scale

<table>
<thead>
<tr>
<th></th>
<th><strong>Czech Republic</strong></th>
<th><strong>Italy</strong></th>
<th><strong>Europe (indicative)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Input EO data (2018-2019)</td>
<td>28 TB</td>
<td>100 TB</td>
<td>2 PB</td>
</tr>
<tr>
<td>Output L2 data (2018-2019)</td>
<td>34 TB</td>
<td>123 TB</td>
<td>2 PB</td>
</tr>
<tr>
<td>Output L3 data (2018-2019)</td>
<td>14 TB</td>
<td>50 TB</td>
<td>1 PB</td>
</tr>
<tr>
<td>Processing &amp; pre-processing resources (ongoing)</td>
<td>16 cores, 128 GB</td>
<td>32 cores, 256 GB</td>
<td>500 cores, 4 TB</td>
</tr>
<tr>
<td>Distribution resources (ongoing)</td>
<td>8 cores, 64 GB</td>
<td>16 cores, 96 GB</td>
<td>50 cores, 352 TB</td>
</tr>
</tbody>
</table>
From Satellites to Compliance - Implementation

Sentinel-1 & -2
EO products
In-situ data

Cloud Technology (DIAS)

Use Cases w/ Paying Agencies

WMTS
WMS
WCS
API
DIAS assessment and migration plans

**DIAS assessment:**
- Sen4CAP requirements definition
- RFI document to the 5 DIAS-es
- 2 weeks of services verification
- Results:
  - Data availability/offer
  - Data access reliability
  - ICT performance

Selection in progress to be ready end of 2018 for continuous processing in 2019
Sen4CAP: An European Effort to prepare for CAP2020

- Open & operational Sentinel time series enable CAP monitoring approach
- Interaction with PA operations for IACS implementation essential
- Sen4CAP tools support automated, E2E monitoring at large scale
- Cloud computing on DIAS will allow for national to European up-scaling
- Open source approach for direct and customizable uptake & sharing
- Hand in hand demonstration in 2019 together with Paying Agencies

http://esa-sen4cap.org