CZECH AGRI Copernicus Project from the user´s point of view

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FRAMEWORK OF THE CZECH AGRI Project:

❑ **Jointly initiated** in December 2015 by DG JRC, ESA and SZIF (Czech Agricultural Paying Agency);

❑ Run within the ESA **Sentinel-2 for Agriculture Project** managed by the Université Catholique de Louvain (CZECH AGRI project - GISAT company);

❑ **To demonstrate the capability of the Copernicus Sentinels for agriculture monitoring and management** to Czech stakeholders;

❑ To demonstrate a **proof of concept** for national **agricultural mapping and monitoring products**;

CZECH AGRI Copernicus Project PRODUCTS:

- **CROP TYPE MAP 2015:**
  - Full country
  - Based on Sentinel-1 & 2 and Landsat 7 & 8 time series
  - Winter cereals, winter rapeseed, spring cereals, maize, sugar beet, potatoes and fodder crops
  - Temporal extent: Whole crop growing season

- **EARLY CROP TYPE MAP 2016:**
  - Regional (eastern part of CZ)
  - Based on Sentinel-2 time series
  - Winter cereals, winter rapeseed, fodder crops
  - Temporal extent: March 2016

- **CROP TYPE MAP 2016:**
  - Full country
  - Based on Sentinel-1 & 2 (complemented by Landsat 7 & 8) time series
  - Whole crop growing season

Crop type map 2015

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CZECH AGRI Copernicus Project:

- **PRODUCT SPECIFICATIONS:**

  – **Spatial coverage**: **Full country**
  – **Spatial resolution:** 20 meters / LPIS polygons
  – **Temporal extent:** Whole crop growing season
  – **Temporal frequency:** 2-4 crop type maps per crop growing season
  – **Geometric accuracy:** RMS < 20m
  – **Thematic accuracy:** Overall accuracy > 80%
    Individual crop accuracy: > 60% (F1-score)
  – **Format:** ArcInfo SHP
  – **Cartographic projection:** national (Krovak / S-JTSK)

- **INPUT DATA:**

  – **Satellite imagery**
    - **Sentinel-1 & 2 time series**
    - **Landsat 7 & 8 time series**
  – **Crop parcel datasets**
    - Czech LPIS
  – **Crop in-situ data**
    - In-situ crop data, IACS (crop declaration)

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CLASSIFICATION APPROACH:

- Based on Support Vector Machine (SVM) classifier (pixel based)
- Classification performed under **arable land mask derived from LPIS**
- Integrate optical and SAR approaches
- **Two independent classifications:**
  - Optical - based on Landsat 7/8 and Sentinel-2 multi-temporal composites
  - SAR - based on Sentinel-1 monthly composites
- **Integration** - enhanced crop map to improve the maximum overall accuracy - using maximum posterior probability within the LPIS polygon
- **Aggregation** - crop with largest area within the LPIS polygon

Optical

SAR

Integrated and aggregated into LPIS parcels

CZECH AGRI Copernicus Project:
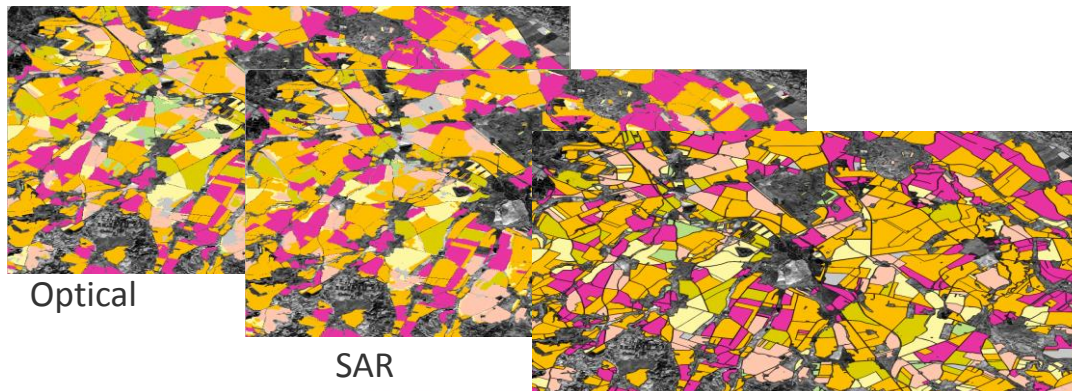
SENTINEL-1 Data & Processing (2015):

- Sentinel-1 GRD IW, Oct2014-Dec2015, operational SciHub, 763 scenes ~ 885GB
- SAR data pre-processing (S1 and SNAP toolboxes)

Precipitation
03 October 2014

Precipitation
0.024 mm
0.023 mm

Precipitation
17.00 mm
12.29 mm

Precipitation
22 October 2014

VH backscatter
03 October 2014

VH backscatter
22 October 2014

Monthly composite
January 2015

CZECH AGRI Copernicus Project:
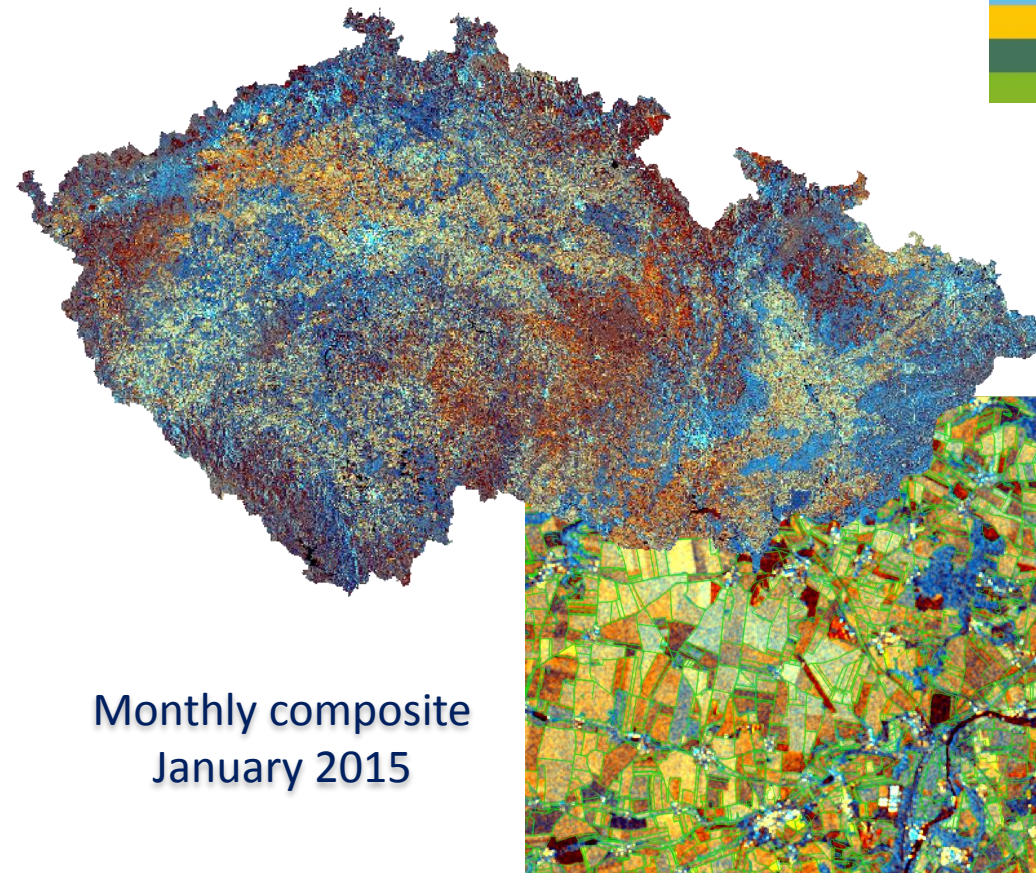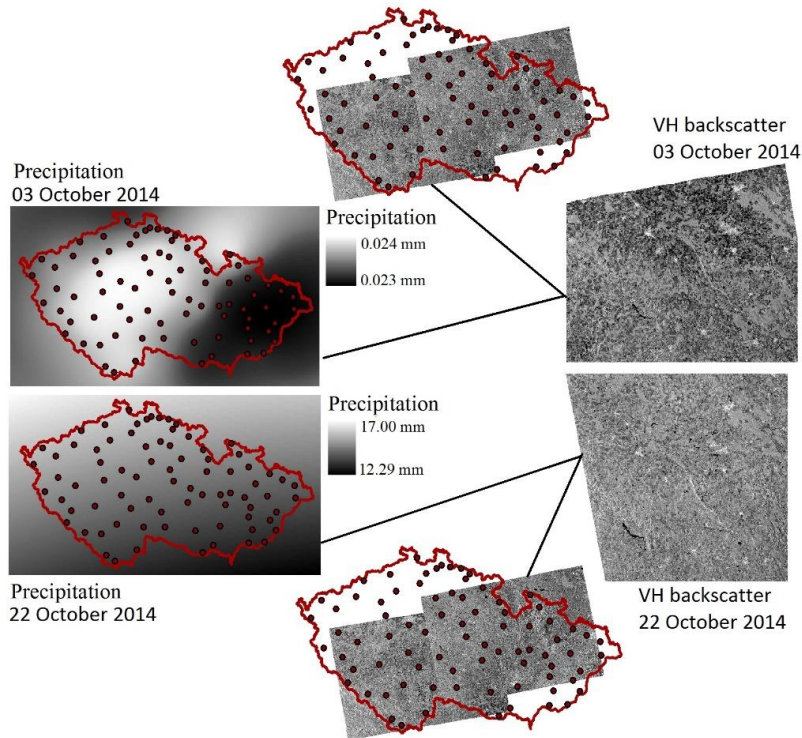
SENTINEL-2 Data & Processing (2015):

- Identified 5 relative orbits over CZ, re-processing of S2 data prior to end of November, total 22 granules ~ 11 GB
  - SEN2COR - atmospheric correction
  - Recode internal cloud masks, all processing steps done by SNAP

Summer composite: August - September 2015
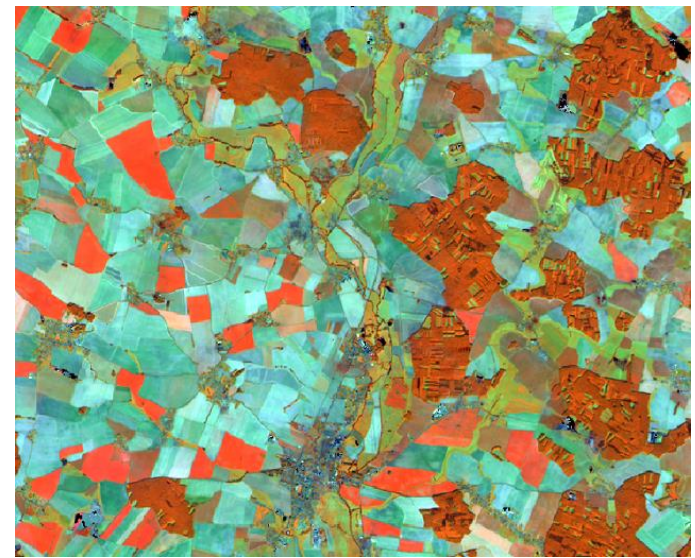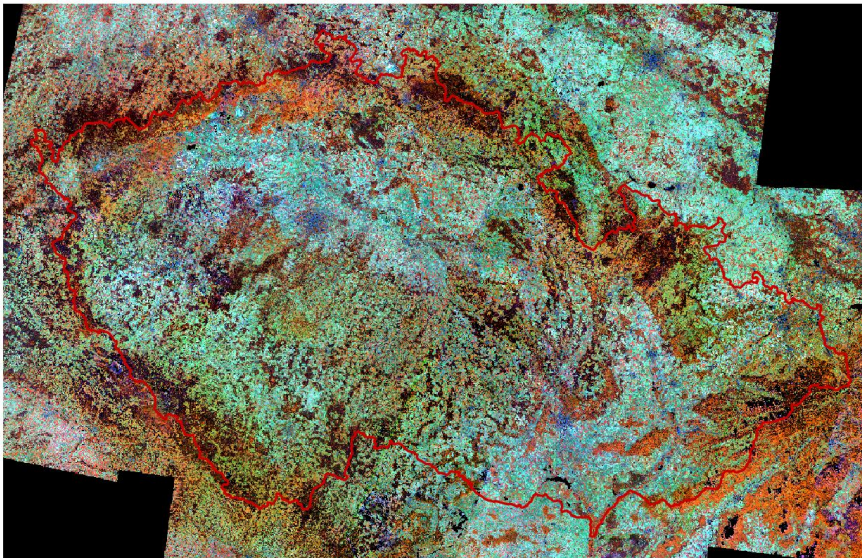
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SENTINEL-2 & Landsat 7/8 Data Processing (2016):

- Jan16-Mar16, Apr16-Jun16, Jul16-Sep16 composites
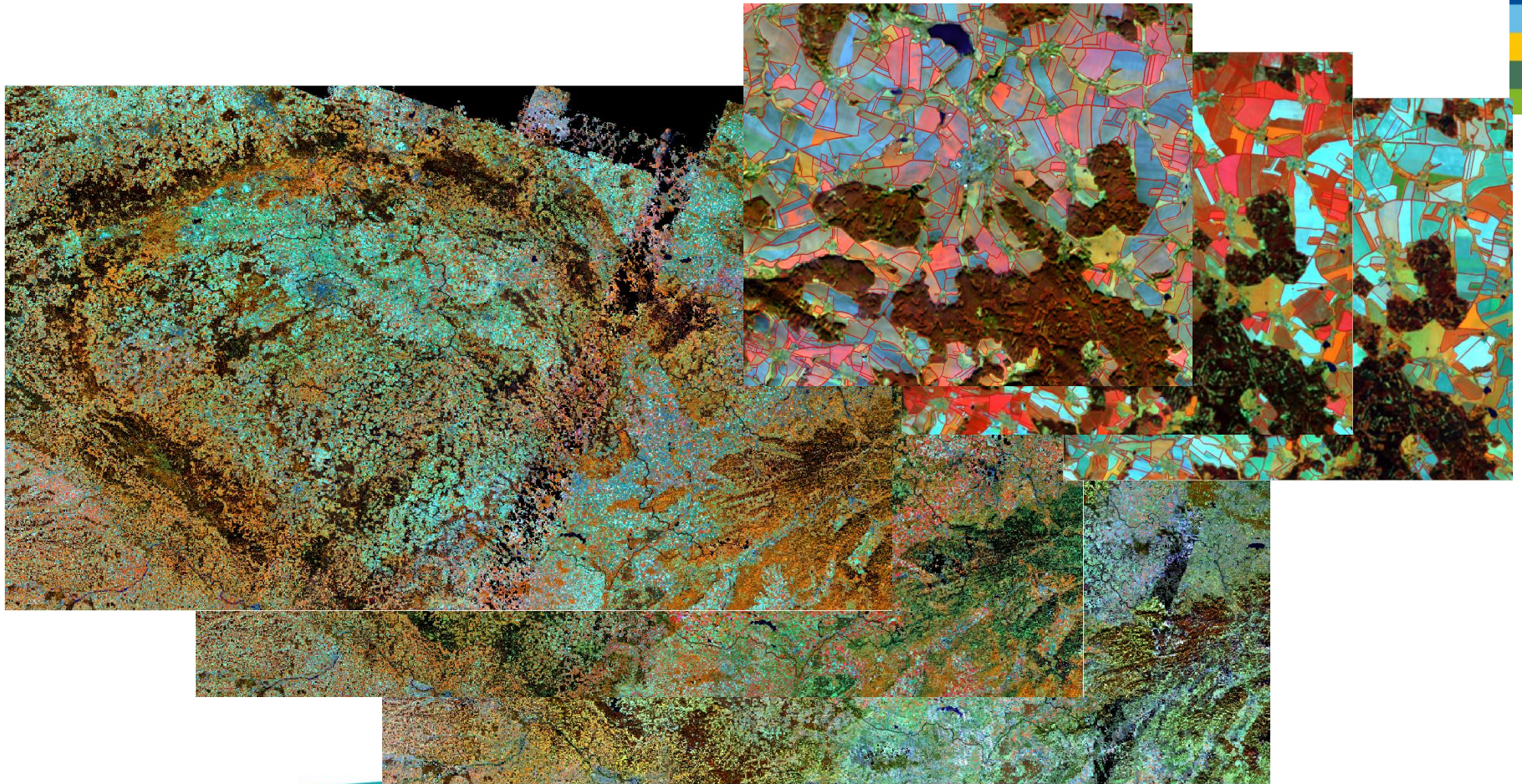
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CROP TYPE MAP 2015:

CROP TYPE MAP 2016:

CZECH AGRI Copernicus Project:

SZIF
Státní zemědělský intervenční fond

INTERNAL VALIDATION 2015 – carried out by GISAT, sample size: 866 LPIS polygons

Class	Crop / crop group	Users accuracy	Producers accuracy	F1 score
1	winter rapeseed	94%	97%	96%
2	winter cereals	92%	98%	95%
3	spring cereals	84%	86%	85%
4	sugar beet	100%	100%	100%
5	maize	81%	94%	88%
6	potatoes	85%	79%	82%
7	fodder crops	86%	68%	77%
8	other annual crops	71%	40%	56%
Mean		87%	83%	85%

Overall accuracy	88%

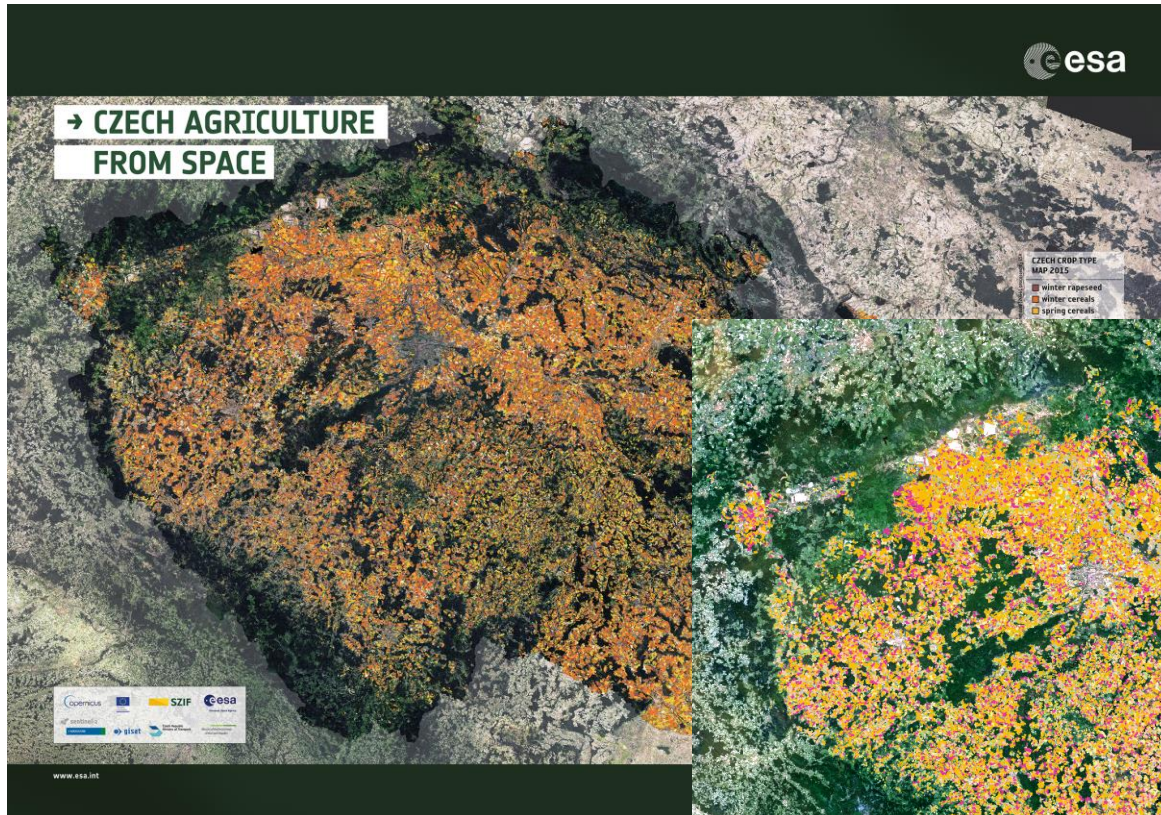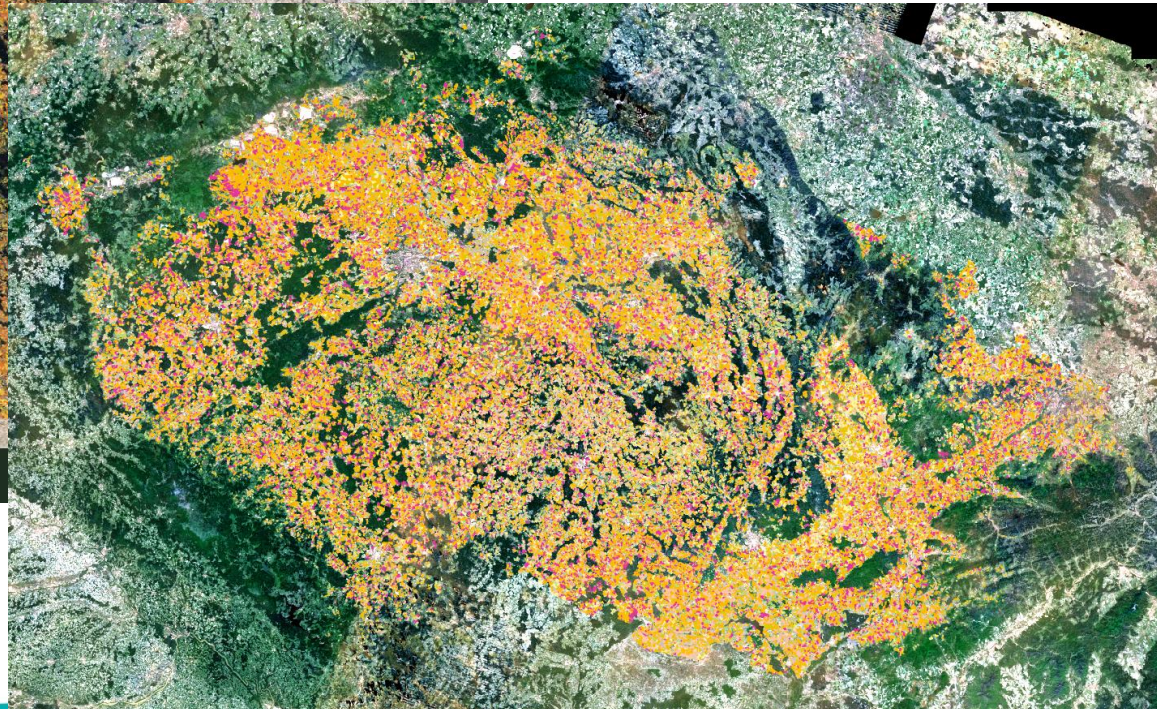| Confusion matrix									
Class	1	2	3	4	5	6	7	8	Total
1	114	2	1	0	0	0	0	0	117
2	3	361	4	0	0	0	1	0	369
3	2	18	158	0	0	0	1	5	184
4	0	0	0	8	0	0	0	0	8
5	0	2	0	0	48	0	0	1	51
6	0	0	0	0	1	11	0	2	14
7	0	9	4	0	2	0	38	3	56
8	2	2	22	0	8	2	4	27	67
Total	121	394	189	8	59	13	44	38	866

EXTERNAL VALIDATION 2015 – carried out by SZIF, sample size: 1485 LPIS polygons

Class	Crop / crop group	Users accuracy	Producers accuracy	F1 score
1	winter rapeseed	95%	97%	96%
2	winter cereals	89%	98%	93%
3	spring cereals	85%	87%	86%
4	sugar beet	89%	89%	89%
5	maize	84%	90%	87%
6	potatoes	89%	80%	84%
7	fodder crops	85%	55%	70%
8	other annual crops	67%	41%	54%
Mean		85%	80%	82%

Overall accuracy	87%

Confusion matrix									
Class	1	2	3	4	5	6	7	8	Total
1	185	3	1	0	0	0	1	0	190
2	3	610	7	0	3	0	1	1	625
3	2	31	274	0	0	0	2	7	316
4	0	1	0	16	0	0	0	1	18
5	0	4	0	0	87	0	2	4	97
6	0	0	1	0	1	24	0	4	30
7	0	26	11	0	3	0	56	5	101
8	4	12	29	2	10	3	4	44	108
Total	194	687	323	18	104	27	66	66	1485

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CZECH AGRI Copernicus Project:

PROJECT RESULTS AND IMPLEMENTATION INTO OPERATIONAL ACTIVITIES (user´s point of view):

➢ **Automated classification** and high **overall accuracy** is promising for the implementation of project outputs at the operational level at the Paying Agency (applications to be further developed);

➢ **Free data** availability (raw data);
➢ **Wide coverage** (national, regional);
➢ High frequency of data capture allowing **effective time series**;

➢ Usable for both **public and private sector**;

CZECH AGRI Copernicus Project:

THE POTENTIAL of SENTINEL DATA (user´s point of view):

- ❑ Use in Agricultural sector, providing useful information in supporting the **administration and control** of the **European Common Agriculture area related subsidies and commitments**;

- ❑ The high frequency of the Sentinel data capture allow regular **monitoring of agricultural production via time series** and therefore **bring added value to both public and private sector** and may serve as a support tool in daily farming activities and Paying Agency tasks;

Mar2015

Apr2015-Jun2015

Jul2015-Sep2015

Multi-temporal composites

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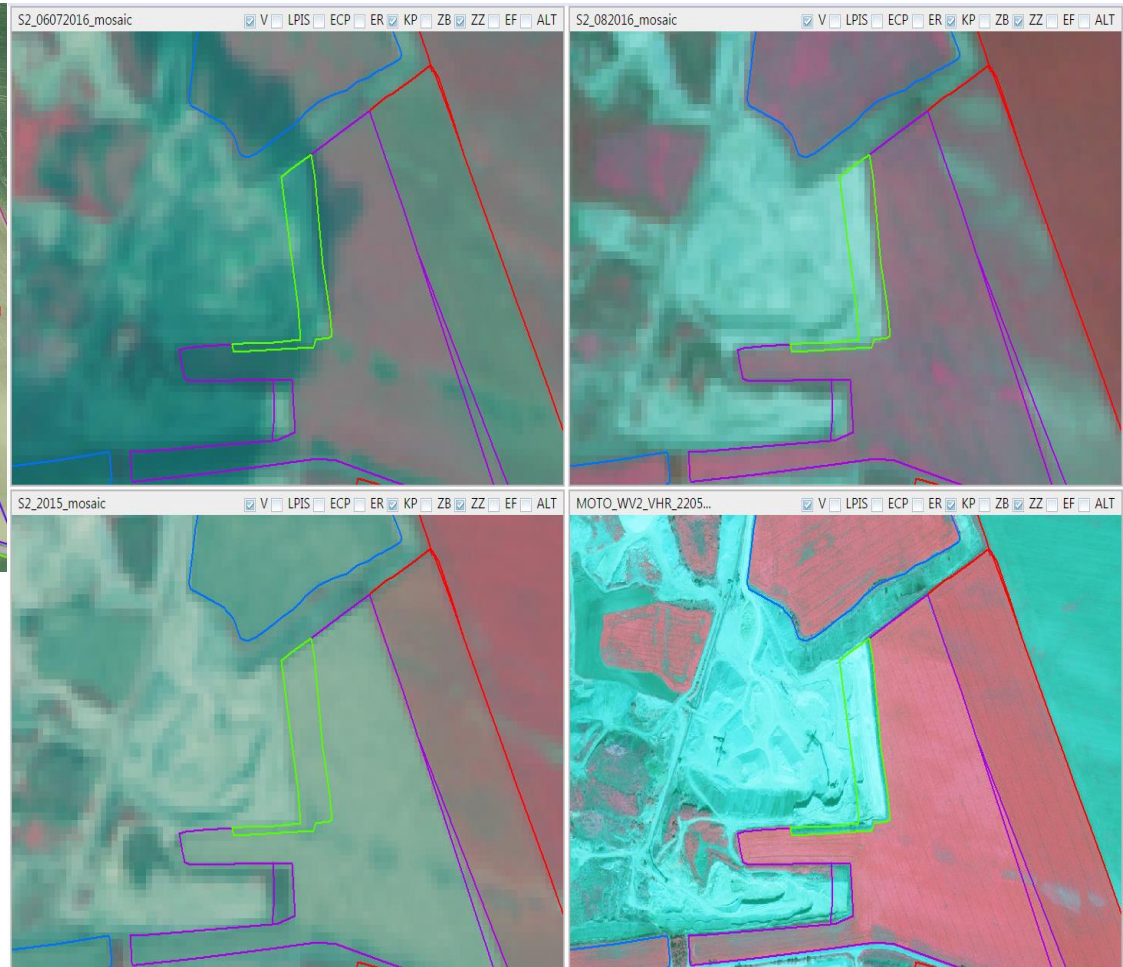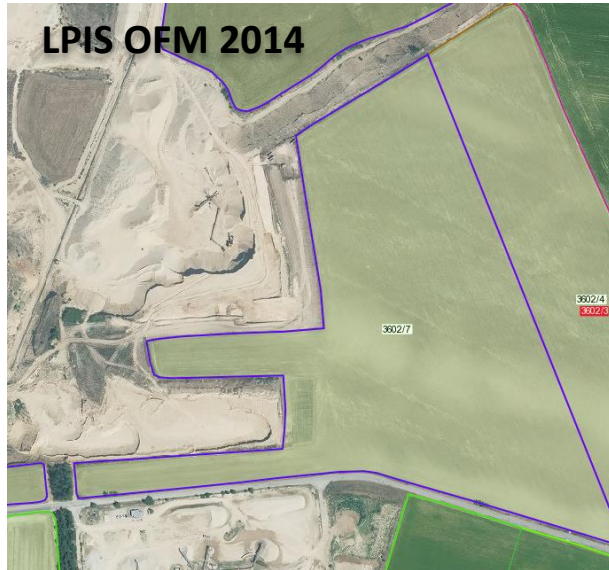
SZIF
Státní zemědělský intervenční fond

SENTINEL 2,1 (support for public and private sector)

Farm advisory system (FAS)
Support in understanding the CAP commitments

Recovery of undue payments
Better traceability of the timeframe of the event for cases of retrospective recovery

LPIS update
Detection of ineligible land; Conversion of grassland, etc.;

Support in submission GeoSpatial Aid Application
Support to farmers with Single Aid Applications

Control with Remote Sensing
Eligibility checks
Cross-compliance checks

IACS cycle (processes managed by Paying Agency)

PRIVATE SECTOR opportunities
Precision farming
Crop monitoring
Zone maps
Yield forecasting
Harvest schedules
Fertilising, etc.

Risk Analysis
Sample selection for On-the-spot checks (CwRS, classical OTSC)

GeoSpatial Cross-checks
Additional Geo information for Cross-checks of Aid Applications

VHR images, in-situ visits
needed to support Sentinel data for some IACS processes. However the **Sentinel data can effectively target the focused groups.**

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EXAMPLE: USE for the LPIS UPDATE

LPIS OFM 2014

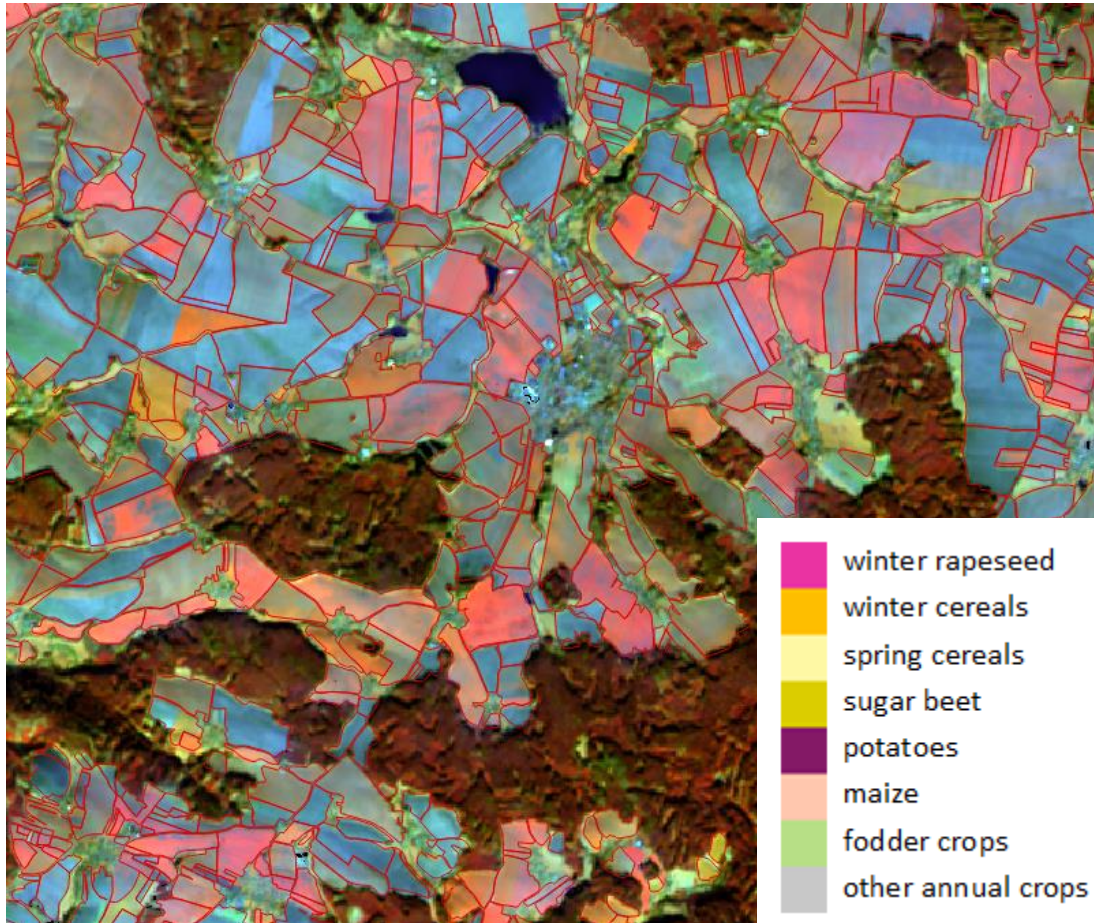**Extension of ineligible area**
(sand mining) in 2016. Area cultivated in 2015. Change not yet visible on LPIS OFM due to 2 year update cycle.
Support tool for LPIS update (identification of areas relevant for update).

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EXAMPLE: SUPPORT FOR AID APPLICATIONS

winter rapeseed
winter cereals
spring cereals
sugar beet
potatoes
maize
fodder crops
other annual crops

**Crop identification prior the submission of aid applications** might support farmers in submission of correct aid applications and limit the level of incorrect crop declarations.

Support tool to farmers and extension offices in process of Aid Application Submission.

Support to meet conditions for „Greening".

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EXAMPLE: RISK ANALYSIS
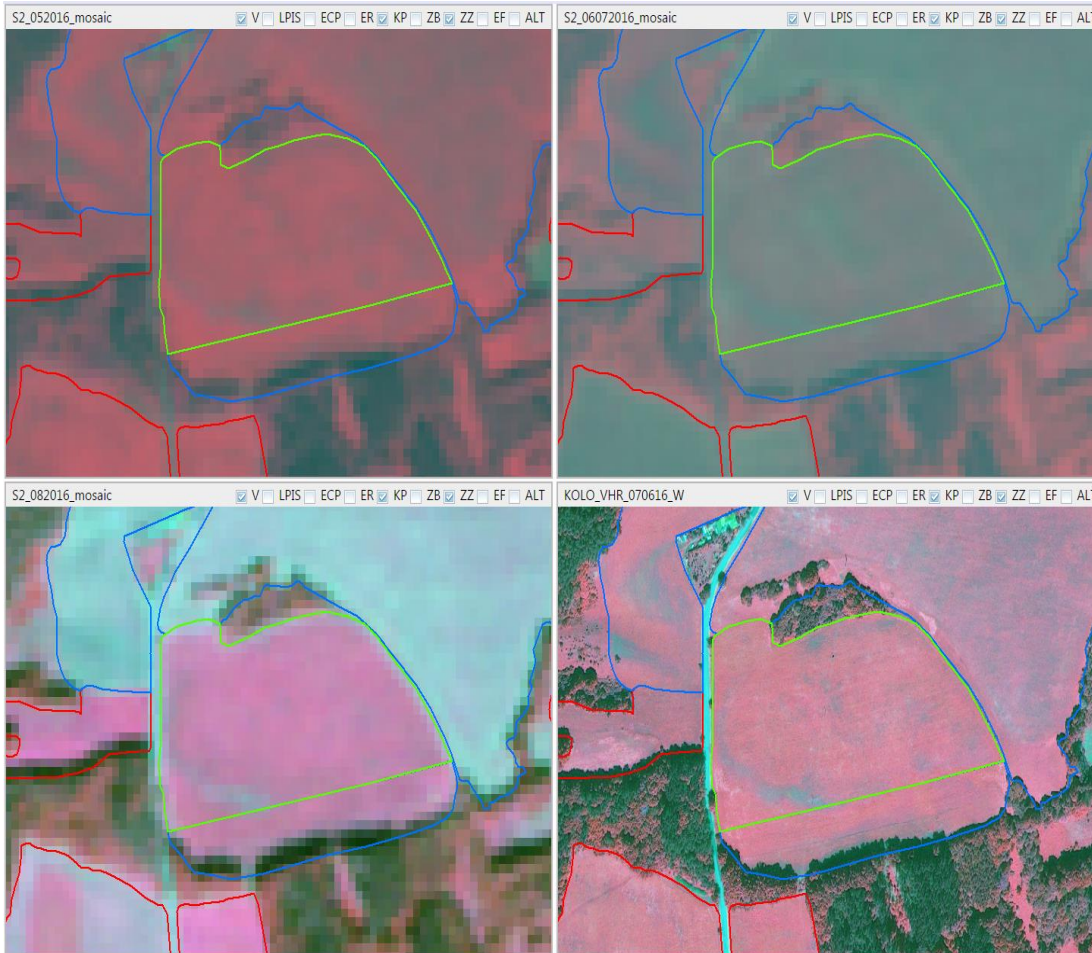
<u>Arable land was declared, but grassland is identified by automated classification</u> might represent potential risk for trying to avoid the conditions for maintaining the grassland/grassland ratio.
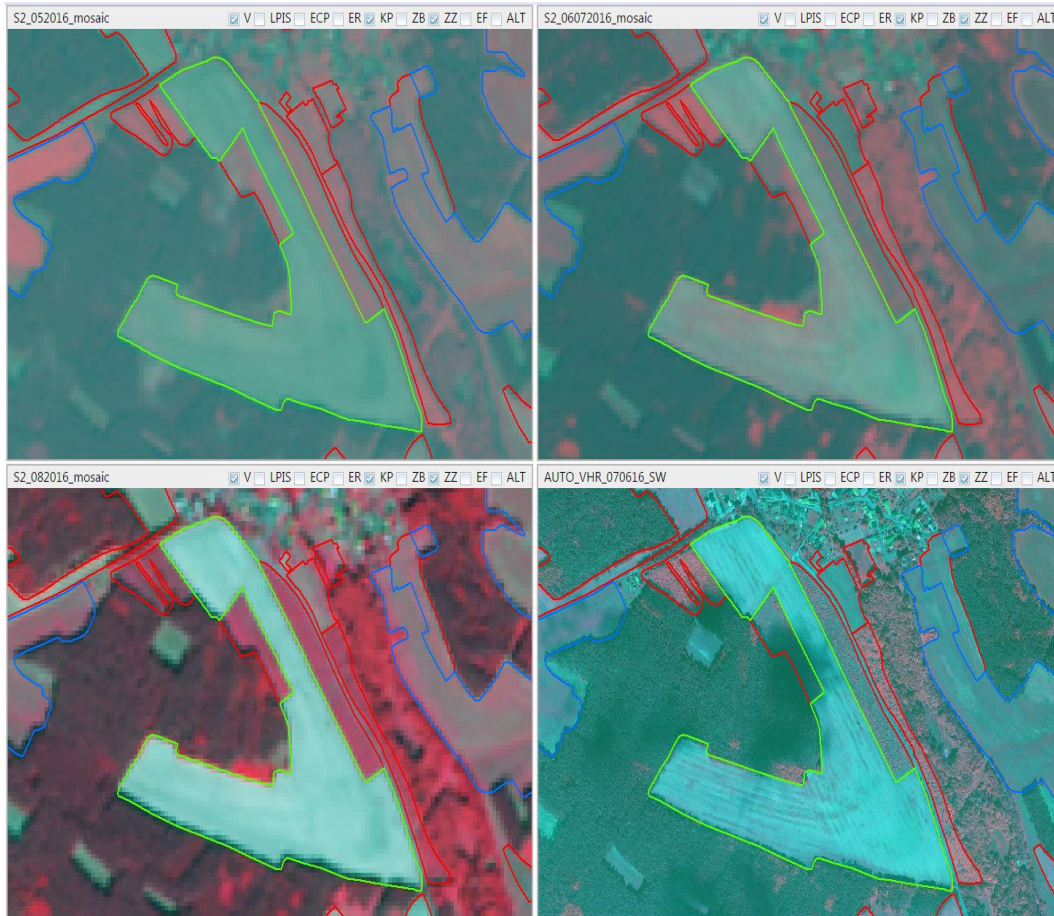
Support tool to more effectively target the potential risk group/situations.

And that way support the sound financial management (for both correct allocation of EU CAP subsidies and national OTSC costs).

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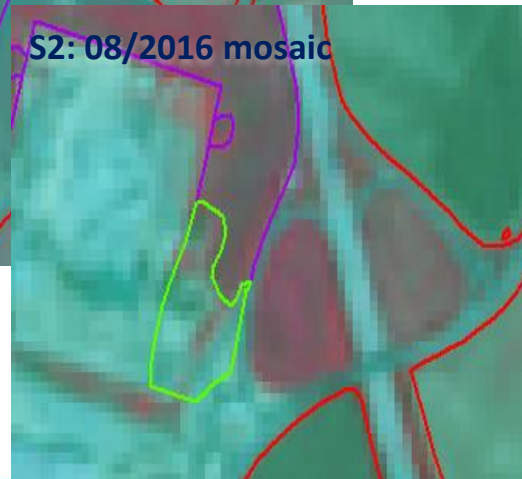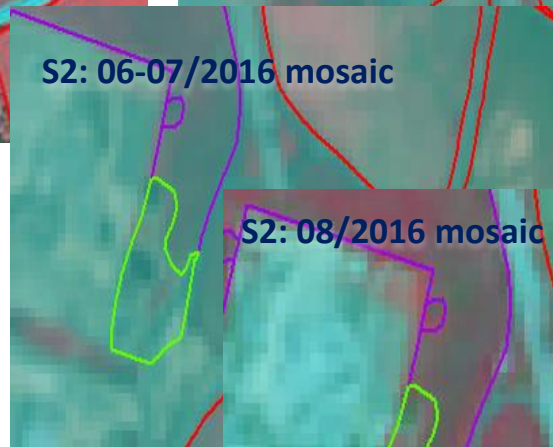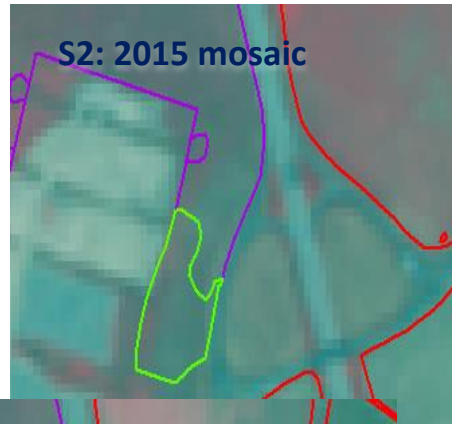
EXAMPLE: CONTROL WITH REMOTE SENSING
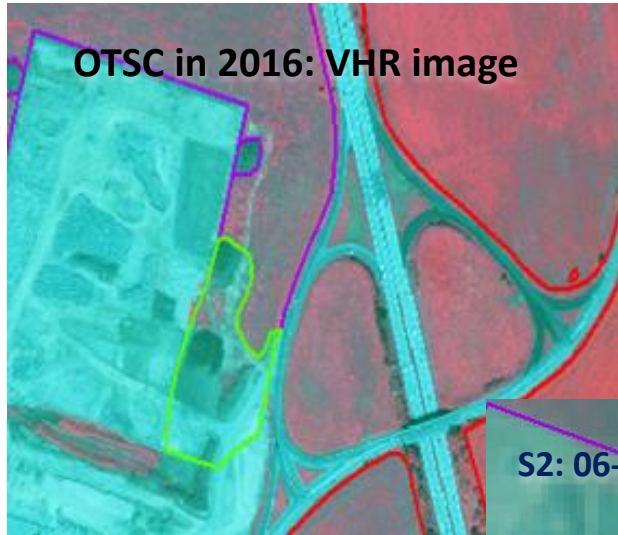

Set-aside was declared in Aid Application and was identified during the CwRS might serve as additional data source for the CwRS.

High frequency of data acquisition, possibilities of multi-temporal mosaics, etc.

Supports more efficient checks for „WIDE AREAS" (national coverage) for the „WHOLE YEAR PERIOD".

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EXAMPLE: RECOVERY OF UNDUE PAYMENTS

OTSC in 2016: VHR image

S2: 2015 mosaic

S2: 06-07/2016 mosaic

S2: 08/2016 mosaic

LPIS OFM (2014)

Ineligible area was found during OTSC in 2016 might represent the case for retrospective recovery for previous year/s;

Support tool for decision whether to apply retrospective recovery.

And allows better traceability of the timeframe of the event for cases of retrospective recovery.

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CZECH AGRI Copernicus Project:

ADDED VALUE OF THE SENTINEL DATA for the PAYING AGENCY IACS AGENDAS:

- ❑ **Whole range of IACS activities (process cycle);**
- ❑ **NOT the resolution but the wide coverage and time series allowing frequent monitoring;**
- ❑ **Mainly automated processing minimising manual inputs;**

Shift from checks on sample at a certain date to ongoing monitoring at national scale (better corresponding to agricultural ongoing activities, heterogeneity of land characteristics and soil parameters);

Involvement in further project studies: defining concrete applications and limitations, definition of frequency of time series, cost x benefits, etc.

Mar 2015   Apr – Jun 2015   Aug – Sep 2015

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CZECH AGRI Copernicus Project:
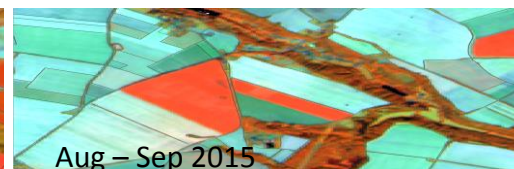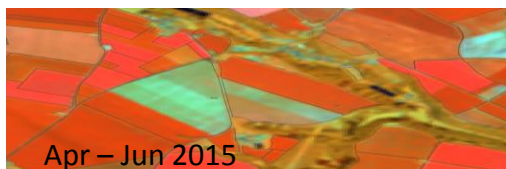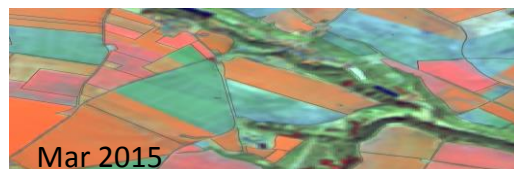
MAIN OPEN ISSUES and FUTURE CHALLENGES:

DATA AVAILABILITY:

- **Constant data availability** (ESA hub limited – need for collaborative ground segment);
- High **storage capacity** and HW requirements;

DATA PROCESSING:

- Assesment of **some data processing** at ESA/collaborative ground segment to minimise costs of overlapping of data processing (e.g. Atmospheric corrections);
- **Further assessments** of possible applications

  (what, when, how, frequency, limitations, etc.);
- **Combination with other reference data** sources

  (e.g. **IACS/LPIS data**) bring added value;

CZECH AGRI Copernicus Project:

MAIN OPEN ISSUES and FUTURE CHALLENGES:

DATA USAGE:

- **Establishment of legislative baseline at EU and national level for public sector** (can we use the data, to what extend, for which purposes, limitations, technical guidelines etc.?);

- **The next Common Agriculture Policy (CAP) Programming Period and the stipulated IACS rules should be refreshed to reflect the possibilities of efficient Sentinel data usage;**

- **Sentinel is NOT ONLY „the potential substitute of Landsat";**
  The best results are achieved by data Integrated approach (S1 & S2, other);

Example of summer composite based on Sentinel-2 Imagery overlaid by the LPIS database (area eastern of Prague)

CZECH AGRI Copernicus Project:

SUMMARY:

❑ Sentinels data bring a **big potential for the use in Agriculture sector** for both public and private sector;

❑ **Further cross wide actions have to be taken at the EU and national level** in respect of methodology, administrative, organisational and IT aspects **to support effective usage of Sentinel data;**

❑ The **frequency of data acquisitions** and possibilities for time series analyses are enormous;

❑ In addition, due to the **wide coverage** the outcomes of the **activities can be monitored on the overall national and regional level** providing framework for the analyses of impact of agricultural policies and activities on the Environment;

Therefore, the use of Sentinel data can support the synergy between the agricultural activities and environmental aspects, and reduce costs of CAP implementation (at EU and national level).

Seminář o možnostech programu
Copernicus pro sektor zemědělství
15/11/2016

Děkuji vám za pozornost.

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Poděkování patří též všem kolegům z projektu.