Jędrzej Bojanowski
jedrzej.bojanowski@igik.edu.pl

EOStat – Agriculture Poland: Services for Earth-Observation-based statistical information for agriculture and verification of farmers' obligations under CAP

Jędrzej Bojanowski[1], Edyta Woźniak[2], Kaupo Voormansik[3], Sebastian Aleksandrowicz[2], Zbigniew Bochenek[1], Katarzyna Dąbrowska-Zielińska[1], Stanisław Lewiński[2], Radosław Malinowski[2], Jan Musiał[1], Marcin Rybicki[2], Tomasz Milewski[4], Przemysław Slesiński[4], Stanisław Sas[5], and Artur Łączyński[4]

[1] Institute of Geodesy and Cartography, Warsaw, Poland [2] Space Research Centre, Polish Academy of Sciences, Warsaw, Poland [3] Kappazeta, Tartu, Estonia
[4] Statistics Poland, Warsaw, Poland [5] Agency for Restructuring and Modernisation of Agriculture, Warsaw, Poland

Project aim

The ESA EOStat project aims at providing evaluated and documented tools for automatic processing of satellite data for:

- acquisition of statistical information for agricultural production (for Statistics Poland)
- verification of farmers' obligations under the Common Agricultural Policy (for Agency for Restructuring and Modernisation of Agriculture)

Crop types

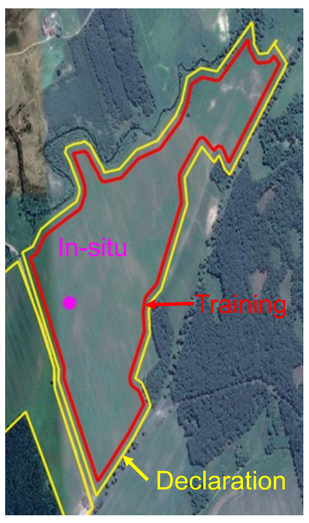
Winter wheat	Oat
Spring wheat	Rye
Winter triticale	Buckwheat
Spring triticale	Rapeseed
Winter barley	Maize
Spring barley	*Grasslands*

Area and period of interest

Two testing NUTS-2 areas (Wielkopolskie, Warmińsko-Mazurskie) in 2017-2018

National scale in 2019

In-situ data



- Field campaigns of Statistics Poland for 2017 and 2018 (> 500 fields for each region)
- Field campaigns of IGIK for 2018 at the Wielkopolska JECAM site (60 fields)
- Farmers' declarations (thousands of samples)

For training/validation fields, to the field geometry from ARMA (declarations, LPIS), we assigned a crop type attribute from in-situ data. Then we applied a 15m inner buffer to reduce the noise from not agricultural pixels.

- Statistics Poland crop yield estimates at NUTS-2 and LAU-1 levels

Parcel- and crop-specific S2 time series with Sen2Agri

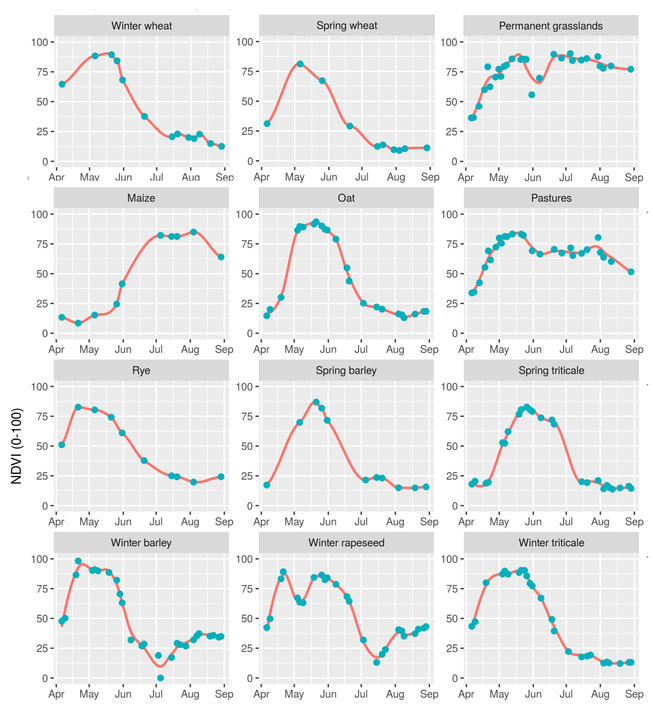
We applied Sen2Agri to perform a crop type classification and to derive NDVI time series for each agricultural field.

Segmentation: ARMA admin. data
Training: 11000 fields of farmers' declarations
Validation*:* 805 in situ data points

Overall accuracy: 0.76
Kappa: 0.74

	Precision (PA)	Recall (UA)	F1
Buckwheat	0.99	0.98	0.98
Maize	0.95	0.99	0.97
Oat	0.53	0.66	0.59
Perm. grasslands	0.99	1.00	0.99
Rye	0.78	0.84	0.81
Spring barley	0.65	0.71	0.68
Spring rapeseed	0.95	0.68	0.79
Spring triticale	0.67	0.36	0.47
Spring wheat	0.63	0.62	0.63
Winter barley	0.93	0.86	0.89
Winter rapeseed	0.78	0.94	0.85
Winter triticale	0.55	0.68	0.61
Winter wheat	0.79	0.70	0.74

The figure below presents the random examples of NDVI mean for individual fields (blue dots). The red curves (smoothed by loess) are added to ease the comparison.



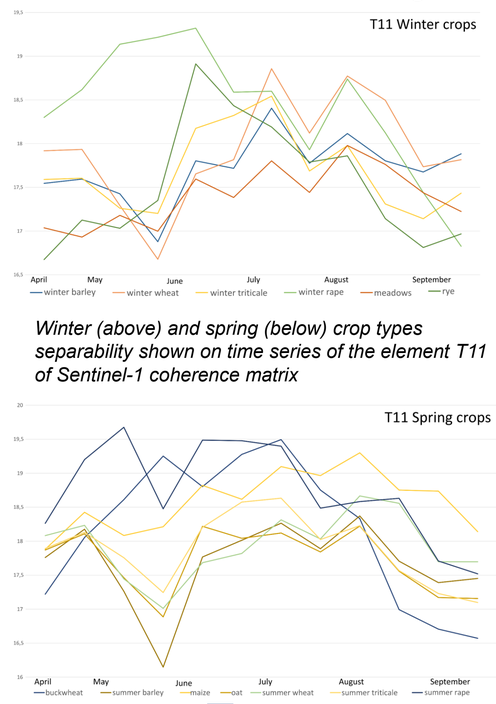
Crop type classification with S1 and S1+S2 data fusion

We performed a crop classification based on time series of Sentinel-1 images:

	Sentinel-2	Sentinel-1
Buckwheat		
Maize		
Oat		
Perm. grasslands		
Rye		
Spring barley		
Spring rape		
Spring triticale		
Spring wheat		
Winter barley		
Winter rape		
Winter triticale		
Winter wheat		

Green – higher F1 score
Yellow – similar F1 score

- Comparison of results of the classifications based on the time series of Sentinel-2 and Sentinel-1 images
- A synergistic classification of time series of Sentinel-1 and Sentinel-2 images (*under development*)



Winter (above) and spring (below) crop types separability shown on time series of the element T11 of Sentinel-1 coherence matrix

Ecological Focus Areas

- Detection of nitrogen-fixing plants and control of farmers' declarations.
- Feasibility study on detection of other EFA classes within selected NUTS-2

Crop diversification

Development of a special procedure for automatic control of crop diversification within a farm based on the LPIS cadastral data and classification results.

Crop growth monitoring and yield forecasting

We exploit Sentinel-3 OLCI and SLSTR to provide an assessment of apparent crop growth conditions and operational crop yield forecasting that refer to long-term averages (LTA) derived from low-resolution satellite data records.

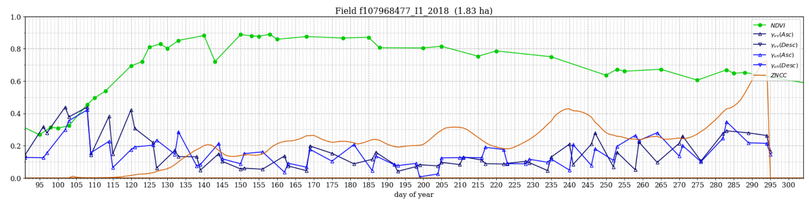
To this end, we aim at:

- inter-calibration of crop indices in optical and thermal domain derived from Sentinel-3 and reference MODIS/VGT/AVHRR imagery
- testing the crop yield forecasting based on S3-derived OGVI/LST related to MODIS-derived fAPAR/LST LTA, and fitted against the growing degree days

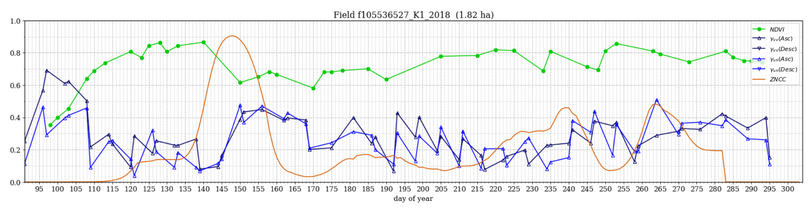
Grasslands monitoring

Sentinel-1 coherence and Sentinel-2 NDVI time series are used for detecting the mowing events. The results are presented on the web map (on the right), where green parcels indicate mown compliant parcels and red not mown non-compliant parcels.

Examples of S1 and S2 time series of two Polish grasslands. Thanks to weather independent Sentinel-1 it is also possible to follow the grassland status during the cloudy periods, when Sentinel-2 NDVI data are not available.



A grassland likely unmown.



A grassland that was mown in June 2019.

Monitoring of agricultural activities

The objective is to develop an operational system for ARMA to monitor agricultural activities at a parcel level. To reach the objective:

- we designed and built a database of S2 derivatives (i.e. radiances, vegetation indices) at a parcel level
- we exploit the Amazon AWS services for a rapid operational extraction of parcel-resolution S2 time series that can serve for crop yield forecasting, detection of agricultural activities and grasslands monitoring
- we develop a methodology for identification of agricultural activities (sowing, harvesting)
- we develop a methodology for identification (yes/no) of catch crops

Project funded by the European Space Agency