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EOStat - Agriculture Poland: Services for Earth Observation-based statistical information for agriculture

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Project aim

The EOStat project aims at developing an EO-based system to support operational activities of Statistics Poland related to gathering statistical information on agriculture. The ultimate objectives are:

- to create a system of EO-based support for acquisition of statistical information for agriculture production in Poland; to assist and support the system implementation at Statistics Poland
- to deliver a suite of evaluated and documented tools for automatic processing of satellite data and derivation of information relevant for agricultural production assessment (i.e., crop maps and crop yield forecasts).
- to provide an assessment of economic viability of the system application in the operational work of Statistics Poland

Project tasks

(1) Development of operational in-season crop type classification routines based on:
- ***multi-temporal S-2 and Landsat composites with Sen2Agri***
- multi-temporal S-1 data
- using S-1 and S-2 data fusion

(2) Development of an approach for operational crop growth monitoring and crop yield forecasting (at LAU-1 level) using apparent Sentinel-3 OLCI data and the long term averages from NOAA/AVHRR data.

(3) ***Assessment of applicability of field-specific S-2 vegetation indices for crop growth monitoring and early warning system.***

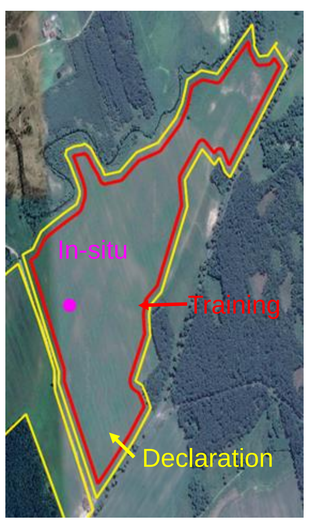
Preliminary results of the tasks marked in ***bold*** are presented below.

Classified crops

Winter wheat
Spring wheat
Winter triticale
Spring triticale
Winter barley
Spring barley
Oat
Rye
Buckwheat
Rapeseed
Green maize
Grain maize

Area and period of interest

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



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)
- In-situ controls of the Paying Agency (ARMA)

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 20m inner buffer to reduce the noise from not agricultural pixels.

Crop type classification with Sen2Agri

We classified crop types for two seasons 2017-2018 and two NUTS-2 regions using two types of training data:

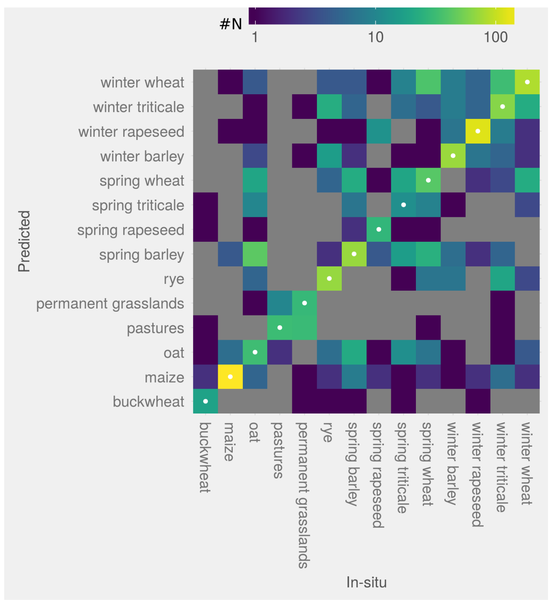
Training: 1000 in-situ samples, Statistics Poland, most reliable

Validation: *5*-fold cross-validation: in-situ data were randomly allocated into *5* groups, classification repeated *5* times using one group as validation data (i.e. 20% data for validation).

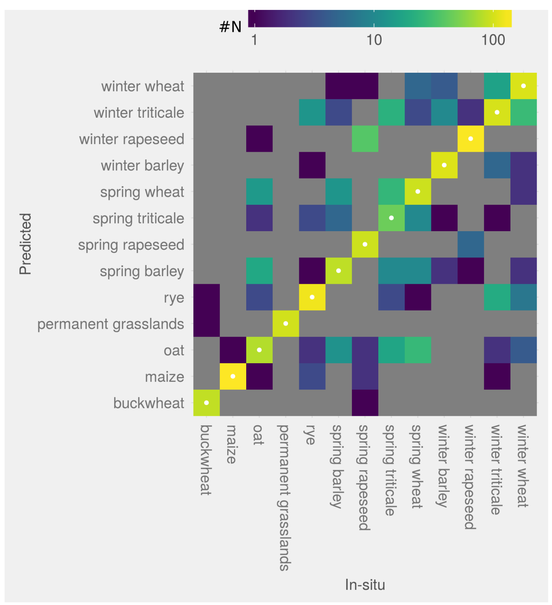
Training: 11000 fields of farmers' declarations, subject to error

Validation: 3000 fields of farmers declarations (i.e. 20% for validation)

Confusion matrix:



Confusion matrix:



Overall accuracy: 0.55, Kappa: 0.5

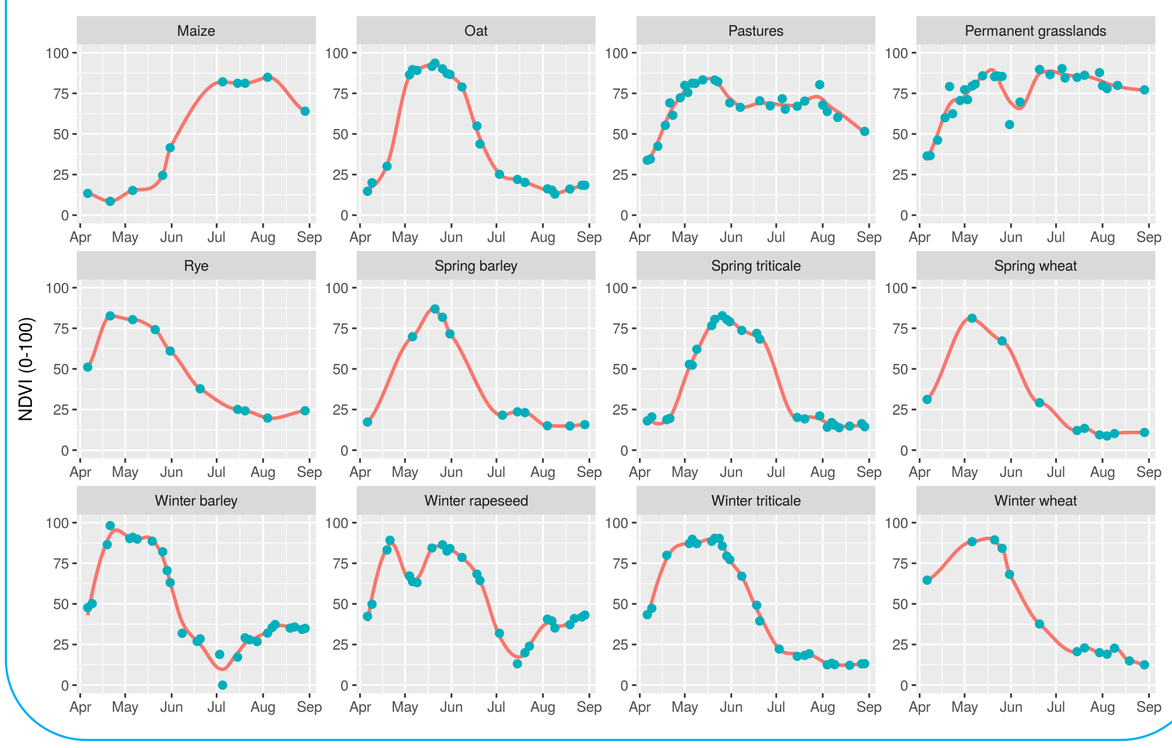
	Precision (PA)	Recall (UA)	F1
Buckwheat	0.78	0.75	0.77
Maize	0.82	0.93	0.87
Oat	0.34	0.26	0.29
Pastures	0.48	0.72	0.58
Perm. grasslands	0.71	0.46	0.56
Rye	0.62	0.53	0.57
Spring barley	0.40	0.49	0.44
Spring rapeseed	0.82	0.55	0.66
Spring triticale	0.28	0.15	0.20
Spring wheat	0.31	0.30	0.30
Winter barley	0.65	0.65	0.65
Winter rapeseed	0.77	0.83	0.80
Winter triticale	0.46	0.43	0.44
Winter wheat	0.44	0.58	0.50

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
Pastures	-	-	-
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

Towards S2-based crop growth monitoring at a field level

We applied Sen2Agri system to derive NDVI time series for 2018 growing season for the AOI. 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. The signal seems to have a negligible noise (e.g. from underestimated cloud cover), allows for spring and winter crops separation, and reveals the agricultural practices (i.e. catch crops and grasslands cutting). Based on these findings, we are going to build a database of NDVI time series for all agricultural fields in Poland and to use it for crop-specific yield forecasting at LAU-1 level.



Conclusions & outlook

(1) Random forest classifier (used by Sen2Agri) trained with a large sample of farmers' declarations (subject to errors!) significantly outperforms the classifier trained with 10 times smaller sample of in-situ data

(2) Except a distinction between spring crops, all crops classified with F1-score above 0.6 (> 0.8 for non-cereals)

(3) Sen2Agri classifications will be compared with S1-based classifications that are under development within the project

(4) Mean NDVI estimates reveal a clear signal of crop development, and therefore can potentially be used for field-specific crop growth monitoring and detection of agricultural practices.

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