CROP YIELD MODELLING APPLYING LEAF AREA INDEX ESTIMATED FROM SENTINEL-2 AND PROBA-V DATA AT JECAM SITE IN POLAND

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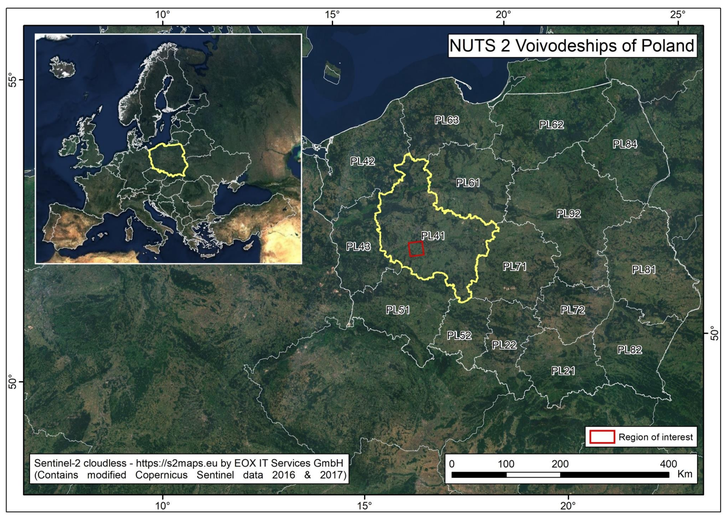
INTRODUCTION

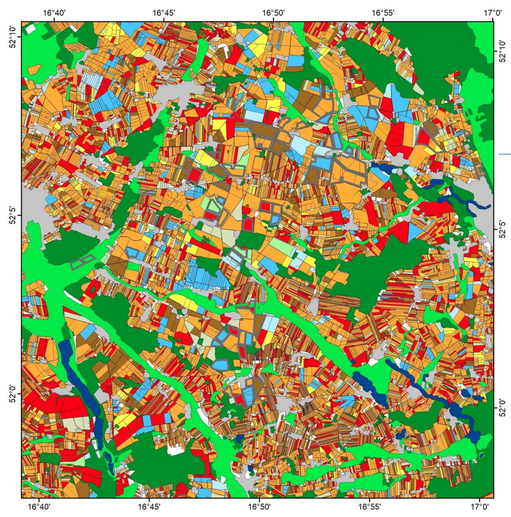
The aim of the project was to examine the applicability of vegetation parameters calculated from Sentinel2 and PROBA-V satellite data for crop yield prognosis. The extensive field measurements have been carried out parallel to Sentinel-2 and Proba-V satellite overpasses in order to elaborate the best relationship between satellite data and in-situ measured LAI. Finally the prognosis model based on meteorological data with the periodical input of LAI for wheat yield prognosis has been applied. Additionally classification of crops over JECAM site in Wielkopolska district was performed for 2016 and 2017 to choose the fields with wheat and with other crops for further research.

JECAM site in Poland



Map of crop classification JECAM site 2018

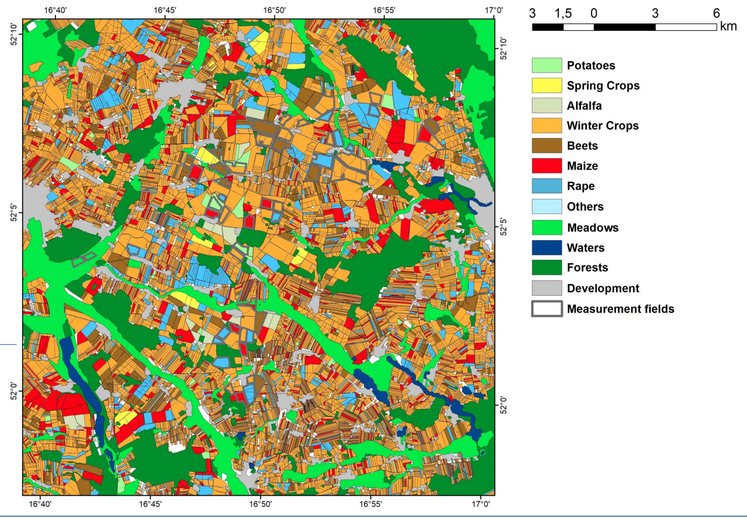
Only optical data (Sentinel-2)
Sentinel-2 Images 2018-04-06, 2018-05-26, 2018-06-20 33UXT



Crops	Producer Accuracy	User Accuracy	Overall Accuracy	Kappa Coefficient
Rape	0,97	0,96	0,8	0,78
Beets	0,81	0,8		
Maize	0,83	0,83		
Alfalfa	0,62	0,59		
Potatoes	0,67	0,61		
Spring Crops	0,76	0,73		
Winter Crops	0,85	0,86		
Others	0,59	0,55		

Crops	Producer Accuracy	User Accuracy	Overall Accuracy	Kappa Coefficient
Rape	0,98	0,96	0,85	0,80
Beets	0,84	0,82		
Maize	0,87	0,83		
Alfalfa	0,66	0,57		
Potatoes	0,67	0,60		
Spring Crops	0,79	0,74		
Winter Crops	0,89	0,89		

Optical (Sentinel-2) +SAR data (Sentinel-1 VH VV, RadarSat-2 HV HH)
Sentinel-1 Images 2018-04-05, 2018-05-05, 2018-05-29, 2018-06-21
RadarSat-2 Images 2018-04-13, 2018-05-07, 2018-05-31, 2018-06-24



IN-SITU MEASUREMENTS

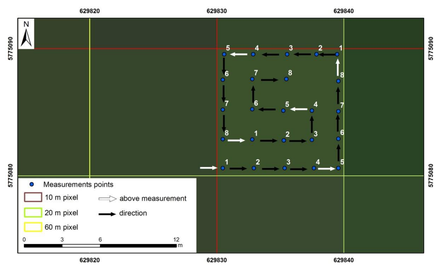
1) Leaf Area Index
(with LAI 2200 Plant Canopy Analyser)
2) Spectral responses
by the ASD FieldSpec4 Hi-Res
3) Chlorophyll fluorescence (with OSP5p+)
4) Soil moisture
(with TRIME Field Measurement Devices)
5) APAR (with AccuPar 80 instrument)
6) Carbon balance (with chamber method)
7) Radiation temperature
(with EVEREST AGRI-THERM II)
8) Chlorophyll
(with FieldScout CM 1000 Chlorophyll Meter)
9) Wet and dry biomass, water content in
(in a laboratory)
10) Type of vegetation cover
and its development stage

All ground measurements have been collected during the satellite overpass. The size of the **Elementary Sampling Unit (ESU)** have been **10 m** for single measurements point.

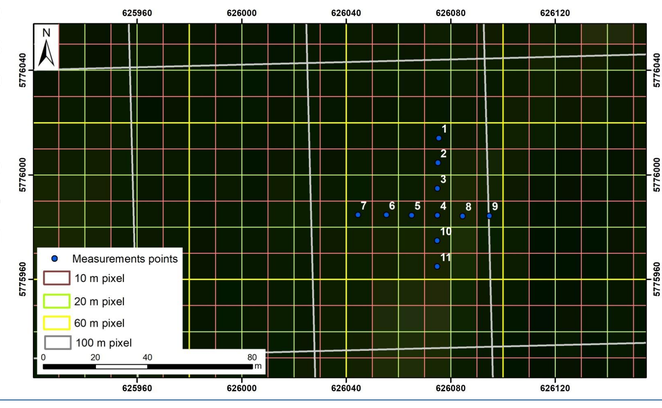
The LAI value consists of an average from the three independent measurements (one measurement=two above and eight below).

In order to better characterize the whole field **the cross-transects** have been designed.

The scheme of LAI measurement



The scheme of cross-transect

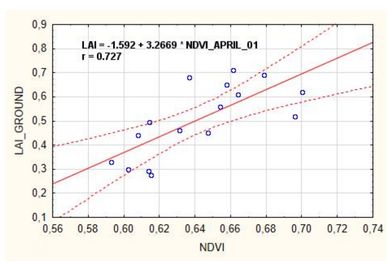


RESULTS

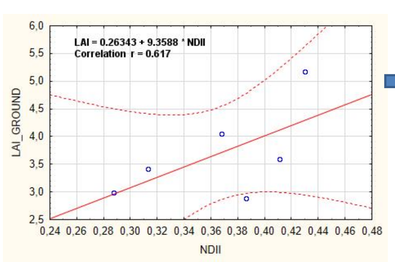
Correlation analysis between ground measured LAI and LAI derived from the selected S-2 and Prova-V based vegetation indices has been done separately for each phase of the growing season and for particular vegetation indices. The aim of analysis was to study temporal variation of precision of LAI estimation and to determine, which indices are most suited to remote sensing based LAI estimation

The PROBE model simulates the daily plant growth. The inputs to the model are basic meteorological data and LAI derived from the best correlation with satellite derived indices. The model calculates the Total Above Ground Mass with the high precision of 95% comparing with the laboratory measurements.

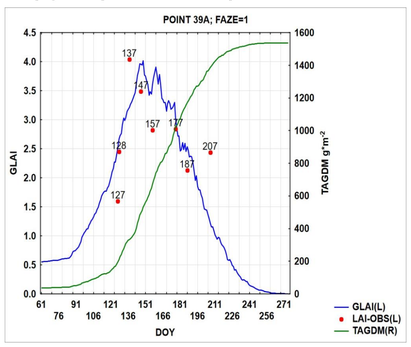
Results of correlation analysis between S-2 based NDVI and ground measured LAI in April



Results of correlation analysis between Proba-V based NDII and ground measured LAI in May

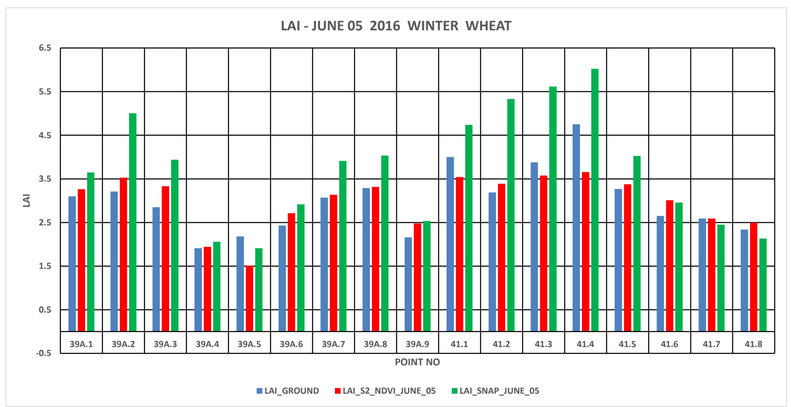


LAI from Model PROBA approach (by Stephan J. Maas)

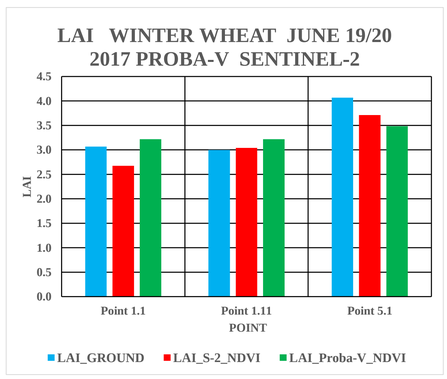


Separate analysis was done for **estimating precision of LAI determination from Sentinel-2 data with the use of SNAP software (Sen2Agri)**. LAI values derived applying this software were compared to ground measured ones. LAI from SNAP software is overestimation compare to ground measurements LAI value.

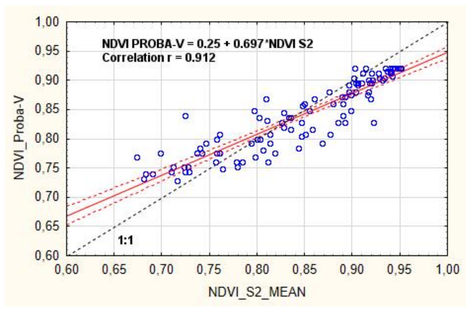
Comparison of LAI derived from Sentinel-2 NDVI and LAI produced from Sentinel-2 by SNAP software and LAI from ground measurements

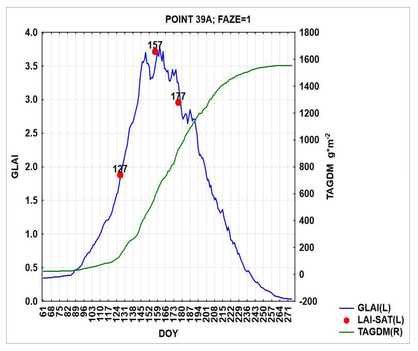


Compatibility of vegetation indices derived from Proba-V and S-2 images depends on phase of plant development. The results of the work point out, that application of both types of satellite data - Sentinel-2 and Proba-V, is justified while keeping proper time of data acquisition and applying appropriate vegetation indices derived from original satellite data and the proper sampling strategy for LAI ground-based measurements.
Vegetation indices derived from Proba-V images at 100 m resolution can be effectively used for LAI estimation when S-2 data are not available, with the assumption, that they are collected at the proper development phase – **heading stage for winter wheat, period which is crucial for yield forecast.**



Results of correlation analysis between S-2 based and Proba-V based NDVI





	[g/m²]
Laboratory biomass	1676
Biomasa from Model PROBA	1580

The work is application of the data for **ESA Project "Land Products Validation and Characterisation in support to Proba-V, S-2 and S-3 missions".**