Land products validation of Sentinel-2, Proba-V, and Sentinel-3 missions for agriculture and grasslands areas: comparison to Copernicus biophysical parameters

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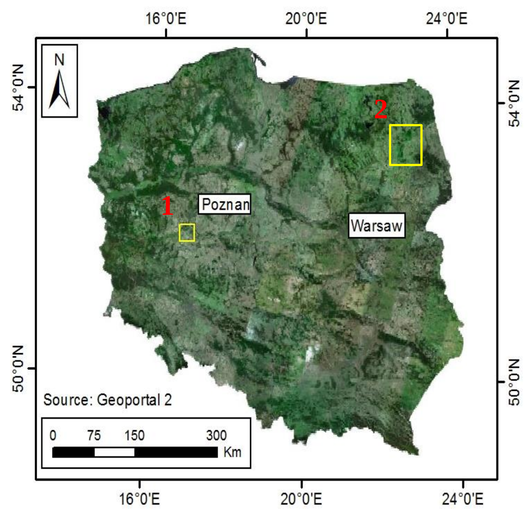
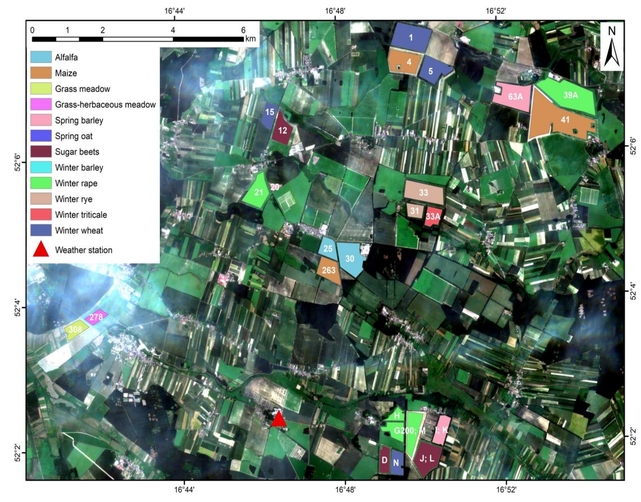
INTRODUCTION

ESA Project "Land Products Validation and Characterisation in support to Proba-V, S-2 and S-3 missions" (No. 4000116440/46/ISBo) has been launched during 2016 in Poland to develop and validate biophysical variables derived from the synergetic use of ESA optical sensors missions, with focus on Proba-V, Sentinel-2 and Sentinel-3. The methodologies are being validated according to standard protocols. Validation data are being collected as part of this project resulting from dedicated field campaigns in agriculture and grasslands areas.

Test sites in Poland

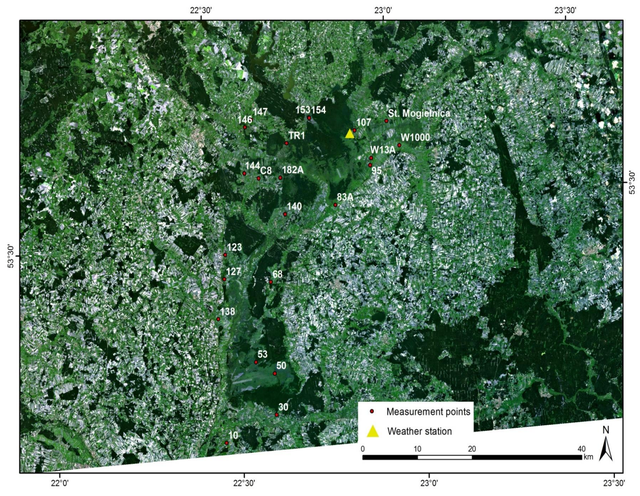


(1) Wielkopolska agriculture – Sentinel-2 Image after Sen2Cor Correction



Sentinel-2 2017-06-20 RGB432

(2) Biebrza wetlands/grassland – Sentinel-2 Image after Sen2Cor Correction

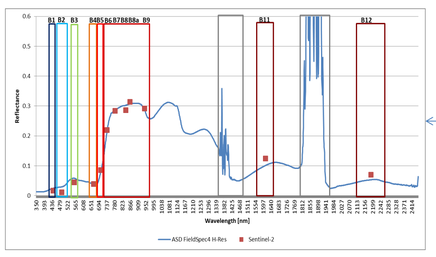


Sentinel-2 2016-06-09 RGB432

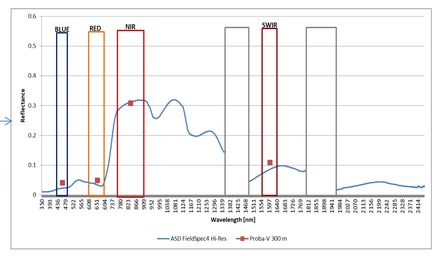
GROUND MEASUREMENTS

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

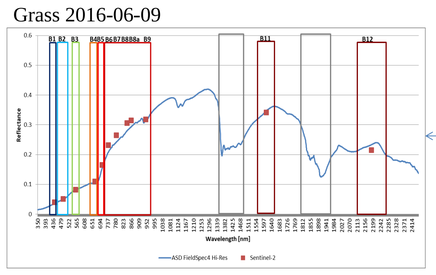
Reflectance by ground measurements and Sentinel-2 Winter wheat 2016-06-25



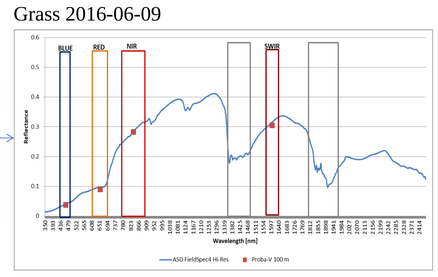
Reflectance by ground measurements and Proba-V Winter wheat 2016-06-25



Grass 2016-06-09

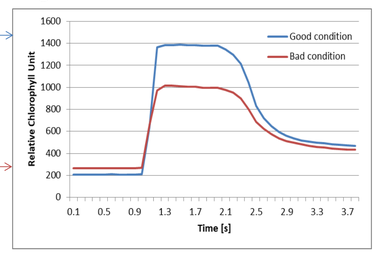


Grass 2016-06-09

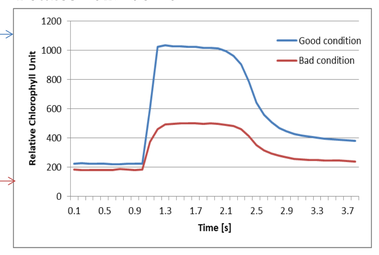


Chlorophyll fluorescence - F_V/ F_M test

Sugar beets 2017-07-31



Potatos 2017-06-20



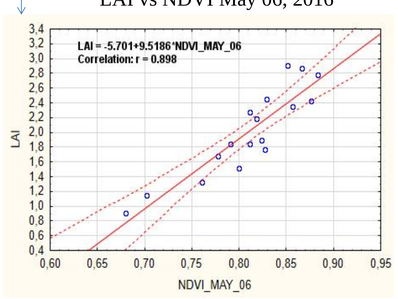
COLLECTED RESULTS

Cross-comparison with available dataset of biophysical variables provided by the Copernicus Global Land service, are taken for verification. First of all, the spectral response of vegetation measured at the ground at the same time as Sentinel-2 and Proba-V acquisition is compared and detailed interpretation of the results have been done. We explored several vegetation indices and textural features derived from visible, near-infrared and short-wave infrared (SWIR) bands The indices like NDVI, NDII, DSWI, TVI are further applied for modelling vegetation growth conditions. The vegetation indices based on SWIR bands (NDII, DSWI) were important to differentiate moisture properties of vegetation (laboratory measurements of vegetation moisture). It was found that some indices correlate well with measured LAI (correlation coefficient r > 0.8), but the strength of correlation highly depends on the phenological phase and type of vegetation.

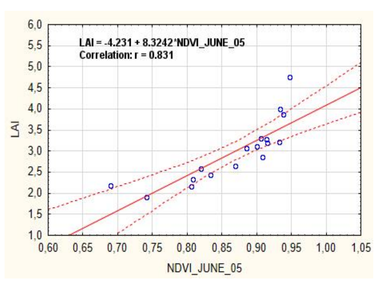
Analysis of Sentinel-2 images – Wielkopolska agriculture winter wheat

Date	NDVI	DSWI	NDII	EVI	TVI	Phenologic al phase
May 06. 2016	**0.898**	0.862	0.853	0.809	0.584	Tillering
June 05. 2016	0.831	**0.889**	0.852	0.862	0.604	Graining (early milk)
June 25. 2016	0.658	0.648	**0.679**	0.618	0.564	Graining (late milk)

LAI vs NDVI May 06, 2016



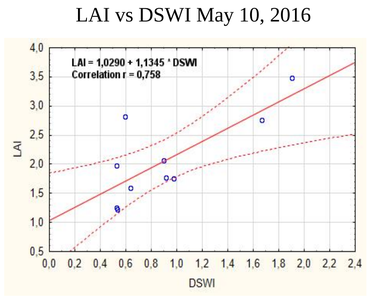
LAI vs NDVI June 5, 2016



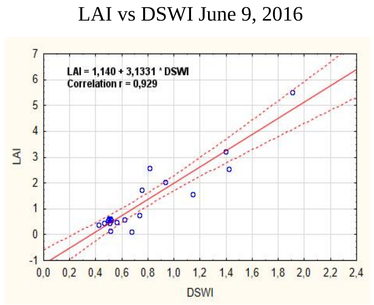
Analysis of Sentinel-2 images – Biebrza wetlands grassland

Date	NDVI	NDII	DSWI	EVI	TVI
May 10, 2016	0.598	0.725	**0.758**	0.675	0.638
June 09, 2016	0.828	0.874	**0.929**	0.749	0.693
August 08, 2016	**0.540**	0.441	0.515	0.262	0.004
September 17, 2016	0.128	0.160	0.189	0.085	0.138

LAI vs DSWI May 10, 2016

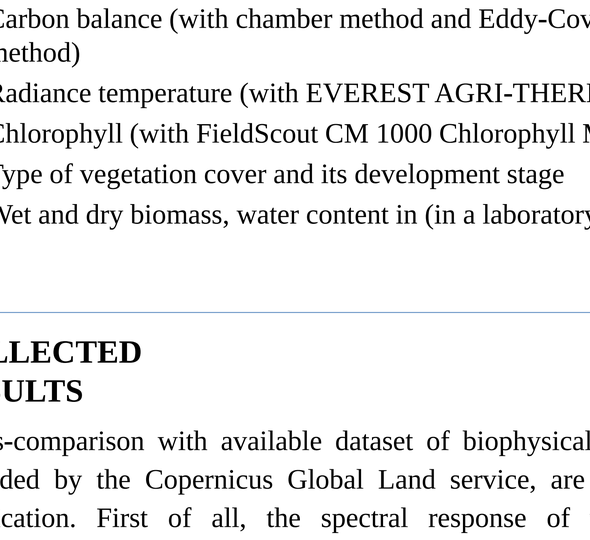


LAI vs DSWI June 9, 2016

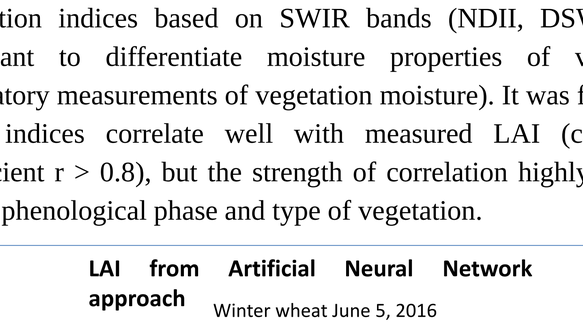


LAI from Artificial Neural Network approach

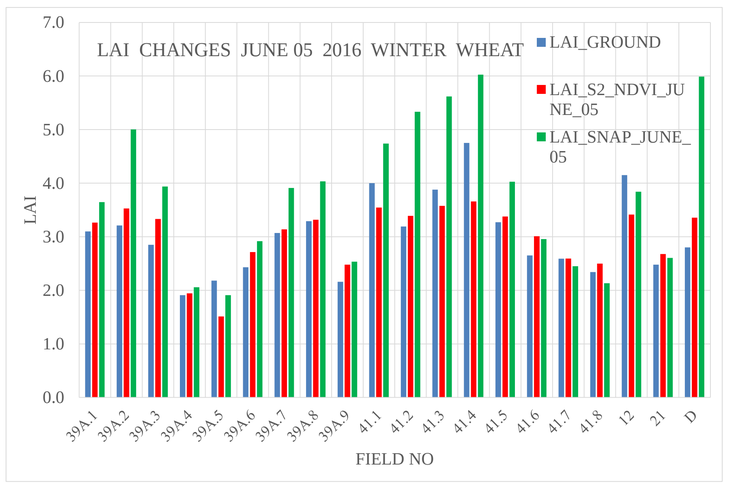
Winter wheat June 5, 2016



Real LAI vs Predicted LAI



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



Point No	LAI_GROUND	LAI_S2_NDVI_JUNE_05	DIFF LAI _GR-S2_NDVI PERCENT	LAI_SNAP	DIFF LAI_GR-SNAP PERCENT
39A.1	3.10	3.26	-5.27	3.64	-17.7
39A.2	3.21	3.53	-9.93	5.04	-55.9
39A.3	2.85	3.33	-16.87	3.93	-38.2
39A.4	1.91	1.94	-1.74	2.05	-7.7
39A.5	2.18	1.51	30.67	1.90	12.4
39A.6	2.43	2.71	-11.65	2.91	-20.0
39A.7	3.07	3.14	-2.18	3.91	-27.4
39A.8	3.29	3.32	-0.80	4.03	-22.6
39A.9	2.16	2.48	-14.78	2.53	-17.3
41.1	4.00	3.54	11.41	4.73	-18.5
41.2	3.19	3.39	-6.23	5.33	-67.2
41.3	3.88	3.58	7.80	5.61	-44.8
41.4	4.75	3.66	22.99	6.02	-26.8
41.5	3.27	3.38	-3.26	4.02	-23.1
41.6	2.65	3.01	-13.60	2.96	-11.6
41.7	2.59	2.59	-0.07	2.45	5.4
41.8	2.34	2.50	-6.80	2.13	8.9
12	4.15	3.41	17.73	3.84	7.4
21	2.48	2.68	-7.92	2.60	-5.0
D	2.80	3.36	-19.85	5.99	-113.9

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

	[g/m²]
Laboratory biomass	1676
Biomasa from Model PROBA	1589