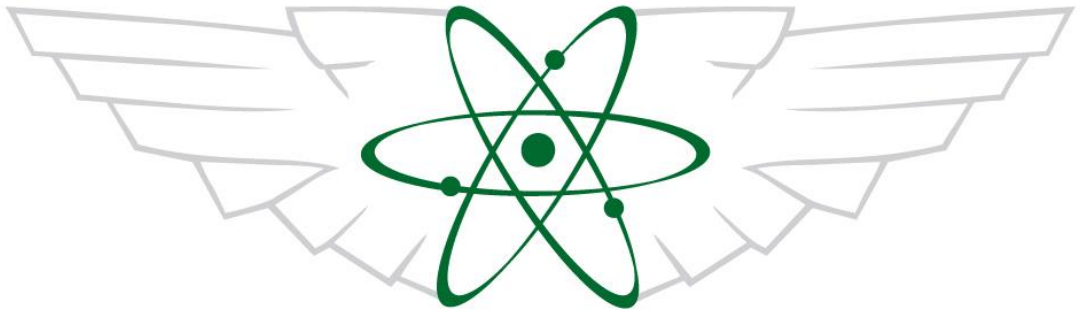
INSTITUTE FOR ENVIRONMENTAL SOLUTIONS



Institute for Environmental Solutions
Dainis Jakovels, Technical Project Manager of PECS projects
dainis.jakovels@videsinstituts.lv, +371 29116741

Sentinel-1 SAR VV (1-15 Dec, 16-31 Dec, 1-11 Jan)

INSTITUTE FOR ENVIRONMENTAL SOLUTIONS

SENTISIMULAT

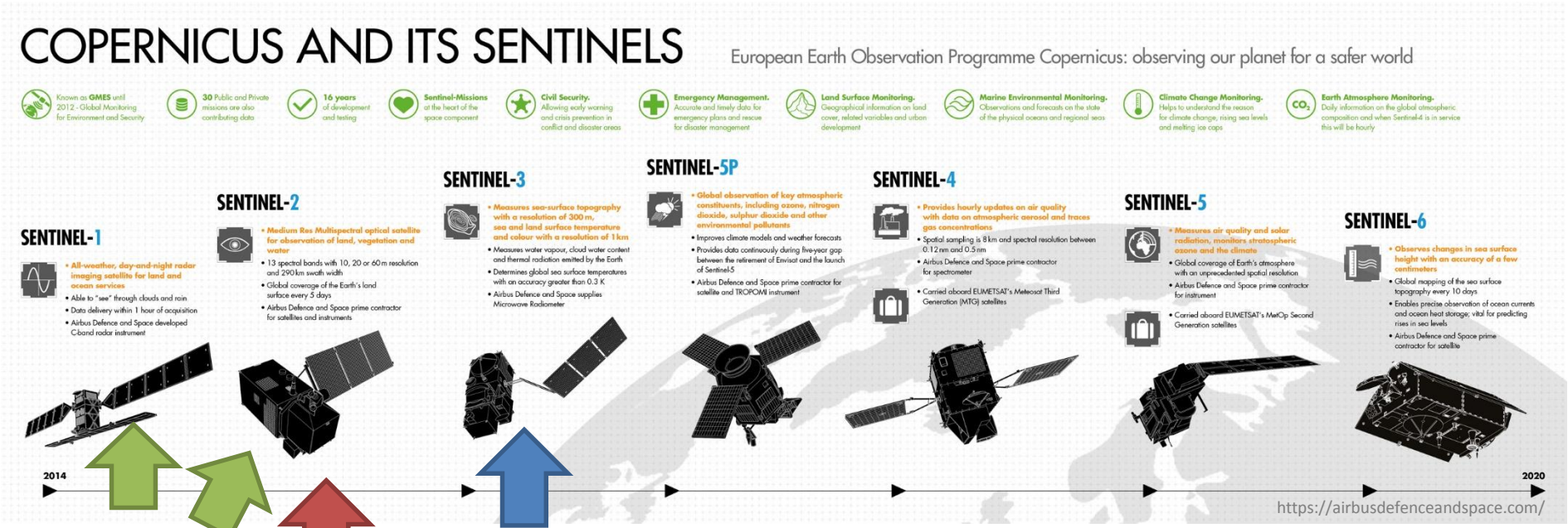
Simulation of Sentinel-2 Images for Land Cover / Land Use Monitoring Using Hyperspectral Airborne Remote Sensing
2015-2017

SENTIGRASS

Assessment of Grassland Quality and Quantity Parameters and Management Activities Using Sentinel-1&2 data
2016-2018

SENTIBALT

Simulating Performance of ESA Future Satellites for Water Quality of the Baltic Sea
2015-2017



SENTIGRASS

SENTISIMULAT

SENTIBALT

INSTITUTE FOR ENVIRONMENTAL SOLUTIONS

SENTISIMULAT

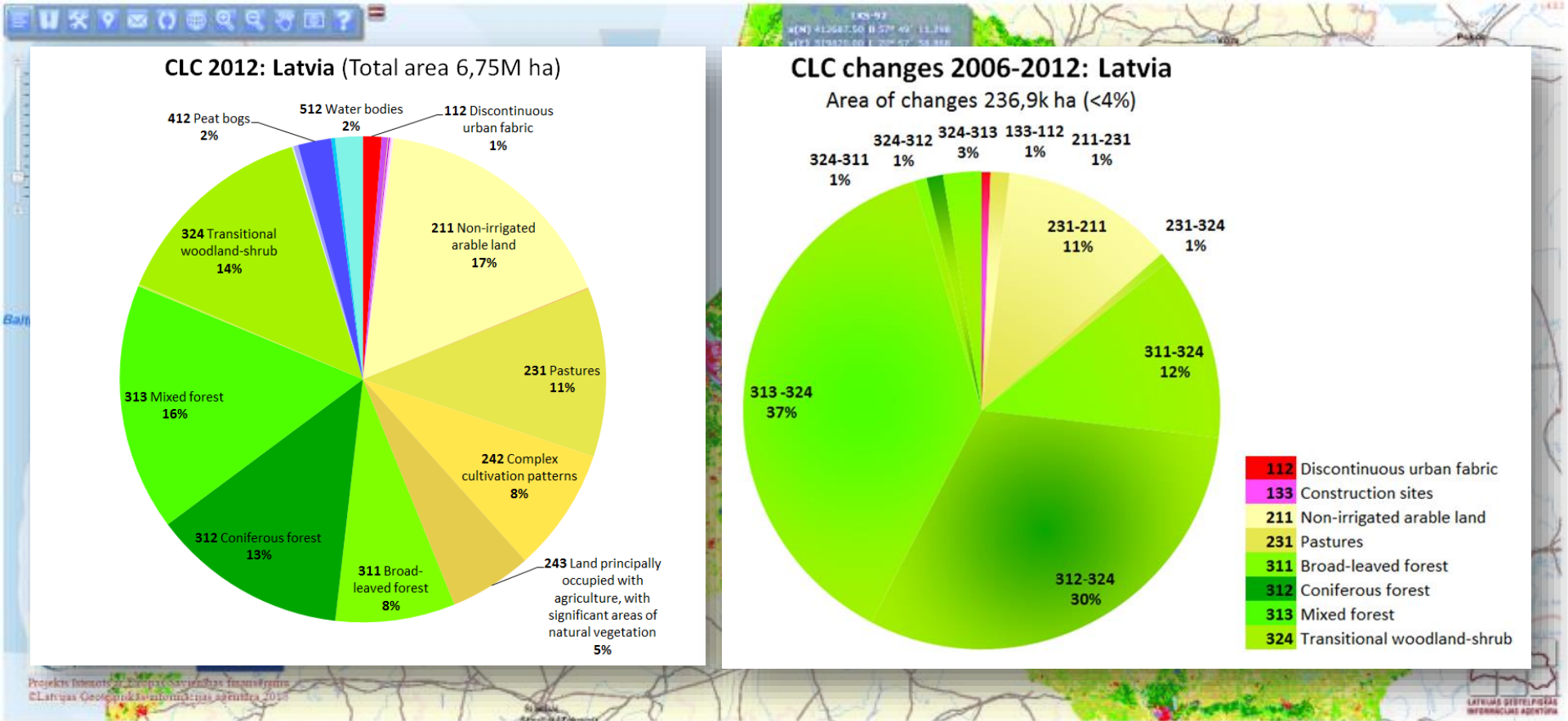
Simulation of Sentinel-2 Images for Land Cover / Land Use Monitoring Using Hyperspectral Airborne Remote Sensing
2015-2017

The project is aimed to develop Land Cover / Land Use classification algorithm for Latvia using simulated and real Sentinel-2 MSI data

Motivation

Land cover mapping in Latvia is performed as part of the Corine Land Cover (CLC) initiative every six years. However, low spatial resolution and accuracy, infrequent updates and expensive manual production have limited its use at the national level.

A snapshot of LGIA Map Browser with Latvian CLC2012 data layer



Classification scheme

Level 1	Level 2	Level 3	Level 4	Level 5
10000 Vegetation	11000 High vegetation (>2m)	11100 Trees (>5m) (MMU 0.1 ha) *CLC 31 Forests*	11110 Coniferous trees *CLC 312 Coniferous forests*	Dominant tree species (optional, input: FLD**)
			11120 Deciduous trees *CLC 312 Broad-leaved forests*	
		11200 Shrubland (2...5m) (MMU 0.1 ha) *CLC 324 Transitional woodland-shrub*	11210 Coniferous shrubs	
			11220 Deciduous shrubs	
	12000 Low vegetation (<2m)	12100 Grassland (MMU 0.3 ha) *CLC 321 Natural grassland*	12110 Dense grass	Agricultural cultures (optional, input: ALD*)
			12120 Sparse grass	
		12200 Agricultural lands (MMU 0.3 ha) *CLC 2 Agricultural area*	12210 Green agricultures	
			12220 Dry agricultures	
		12300 Wetlands *CLC 4 Wetlands*	12310 Inland marshes *CLC 411 Inland marshes*	12311 Inland marshes (water)
				12312 Inland marshes (coastal)
			12320 Peat bogs *CLC 412 Peat bogs*	
20000 Non-vegetation	21000 Water *CLC 5 Water bodies*			
	22000 Artificial/Urban *CLC 1 Artificial surfaces*			
	23000 Bare *CLC 1 Artificial surfaces*	23100 Light bare land		
		23200 Dark bare land		
		23300 Peat extraction sites		

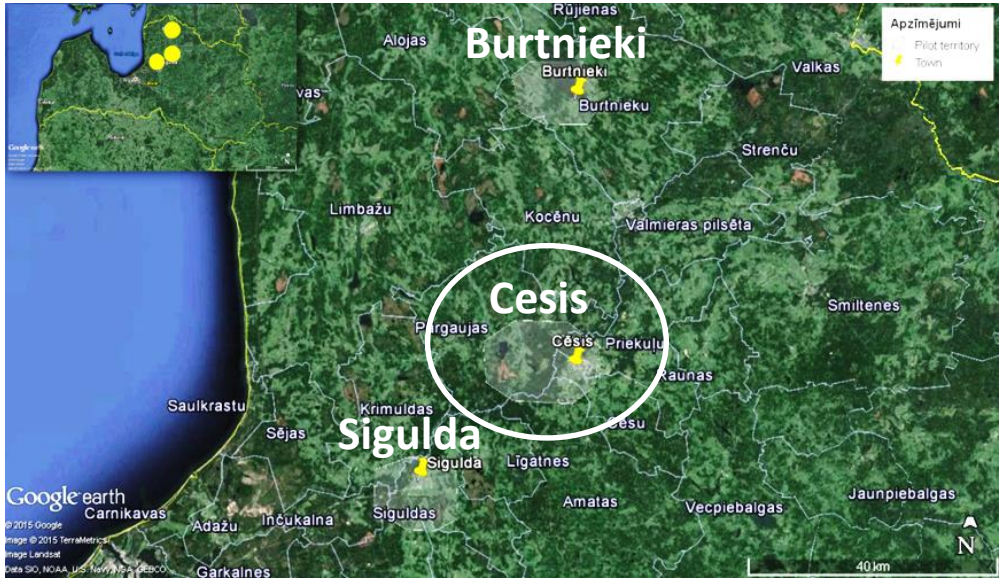
* ADL – Agricultural Land data from the Rural Support Service
** FLD – Forest Land data from the State Forest Service

Supervised pixel-based (20 m/px) classification approach using one-vs-all support vector machine (SVM) classifier was chosen for the development of the algorithm.

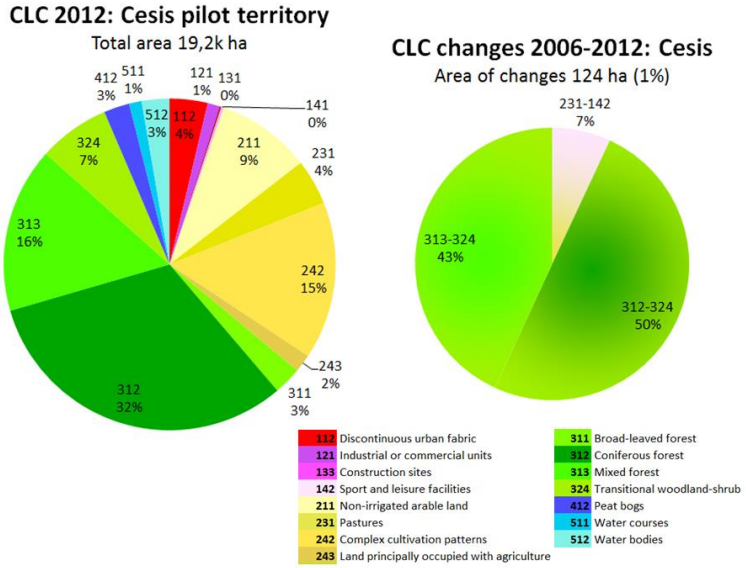
Pilot territories and reference data

INSTITUTE FOR ENVIRONMENTAL SOLUTIONS

Pilot territories

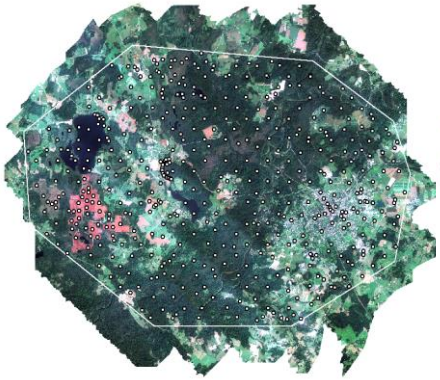


Corine Land Cover data



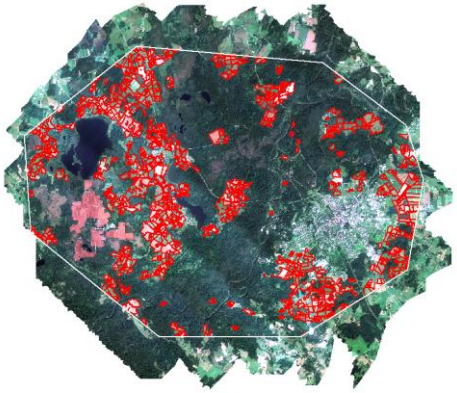
Available reference data

Orthophotos

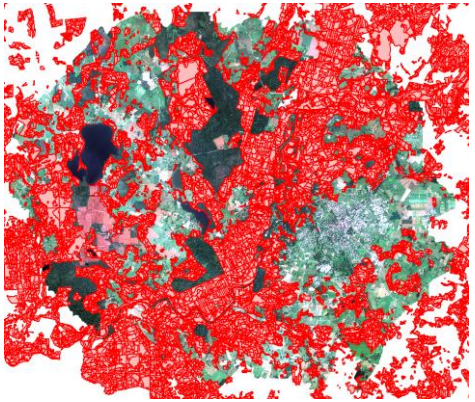


LiDAR data

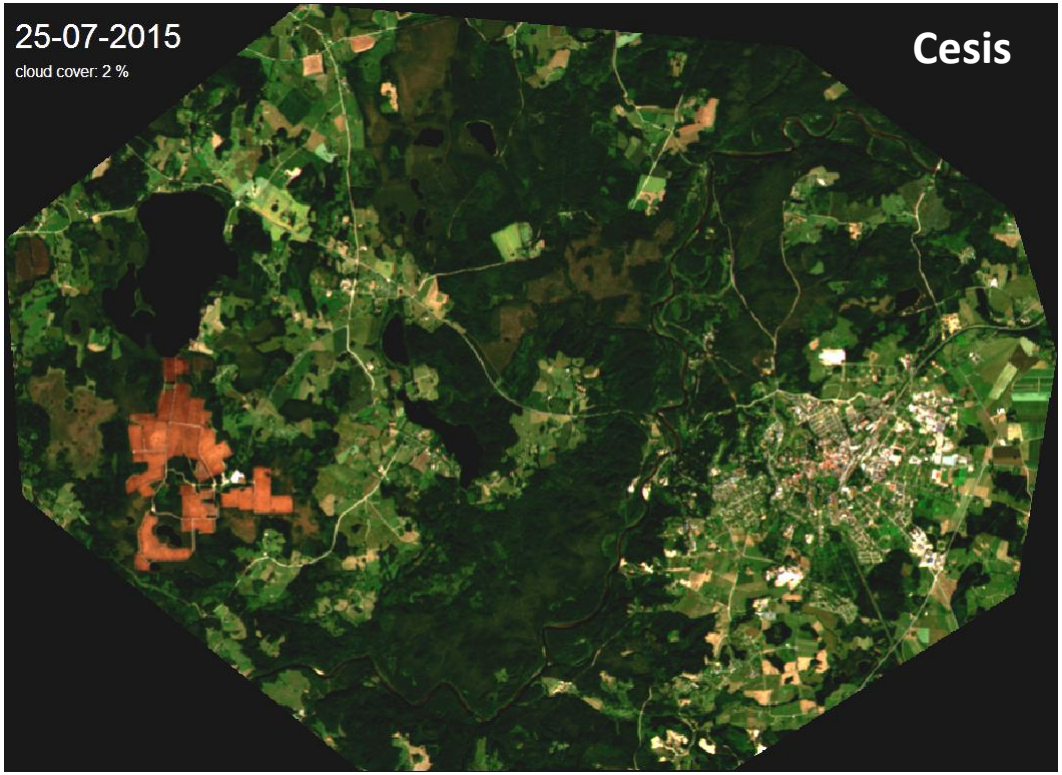
Agricultural land data



Forest land data



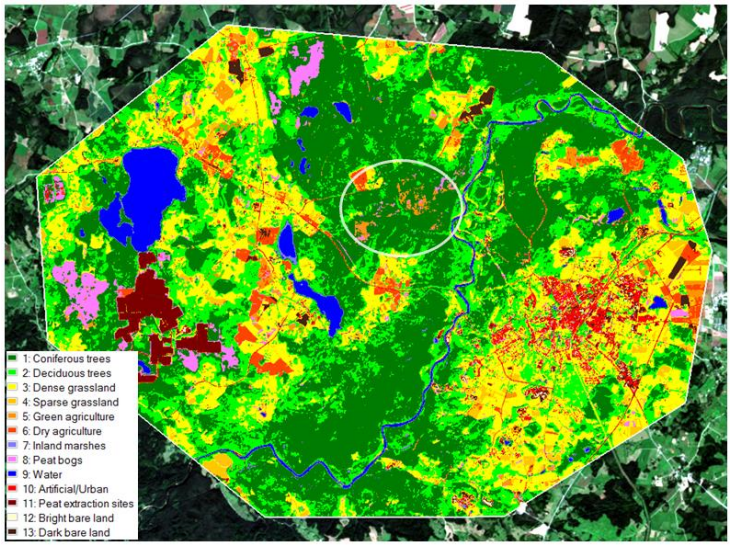
Available Sentinel-2 data



Date	Orbit No	Cloud situation assessment		
		Cesis T35VLD	Sigulda T35VLD	Burtnieki T35VLE
25-07-2015	36	Clear	Clear	Cumulus clouds
04-08-2015	36	Clear	Clear	Clear
14-08-2015	36	Clear	Clear	Clear
21-08-2015	136	Cumulus clouds	Clear	Clear
24-08-2015	36	Clear	Clear	Clear
...				
07-04-2016	136	Cumulus clouds	Clear	Clear
27-04-2016	136	Cumulus clouds	Clear	Clear
30-04-2016	36	Clear	Clear	Cumulus clouds
07-05-2016	136	Partly cloudy	Completely cloud	Clear
06-07-2016	136	Partly cloudy	Partly cloudy	Completely cloudy
25-08-2016	136	Some cumulus clouds	Some cumulus clouds	Cumulus clouds
14-09-2016	136	Clear	Clear	Clear

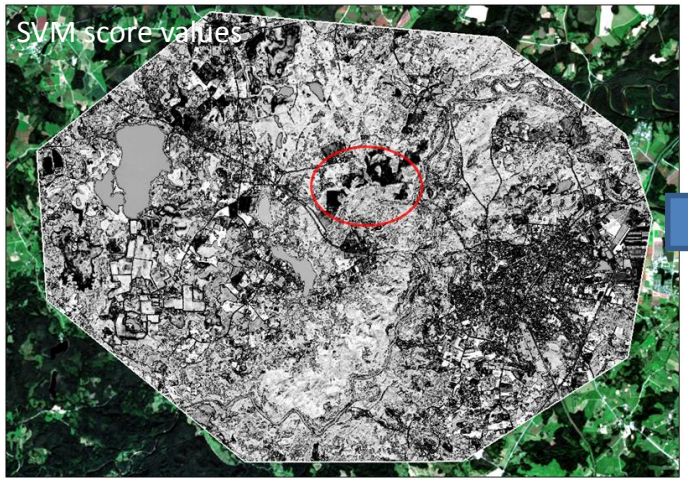
Development of classification algorithm

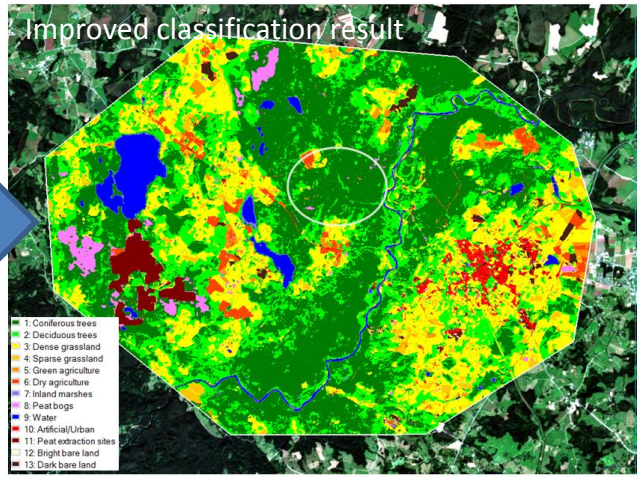
Classification of LC in Cesis from 14.08.2015. Sentinel-2 data using SVM classifier



	Cesis Polygon	Cesis Adapted	Cesis Regular All	Cesis Regular H.Conf.
Overall	**90,5%**	**90,1%**	**67,6%**	**77,2%**
Coniferous trees	87,1%	96,0%	82,0%	87,8%
Deciduous trees	89,2%	79,9%	54,5%	57,0%
Dense grassland	90,6%	90,6%	63,4%	84,2%
Sparse grassland	94,4%	84,5%	48,7%	71,4%
Green agriculture	70,8%	64,2%	70,0%	NaN
Dry agriculture	86,7%	75,4%	31,0%	53,0%
Inland marshes	95,3%	88,3%	15,0%	33,3%
Peat bogs	90,5%	88,0%	70,0%	NaN
Water	97,6%	94,7%	91,7%	100,0%
Artificial/Urban	97,6%	99,0%	98,0%	93,3%
Peat extr. sites	100,0%	100,0%	95,7%	91,4%
Light bare soil	96,2%	98,2%	90,0%	100,0%
Dark bare soil	80,5%	89,4%	57,1%	80,0%

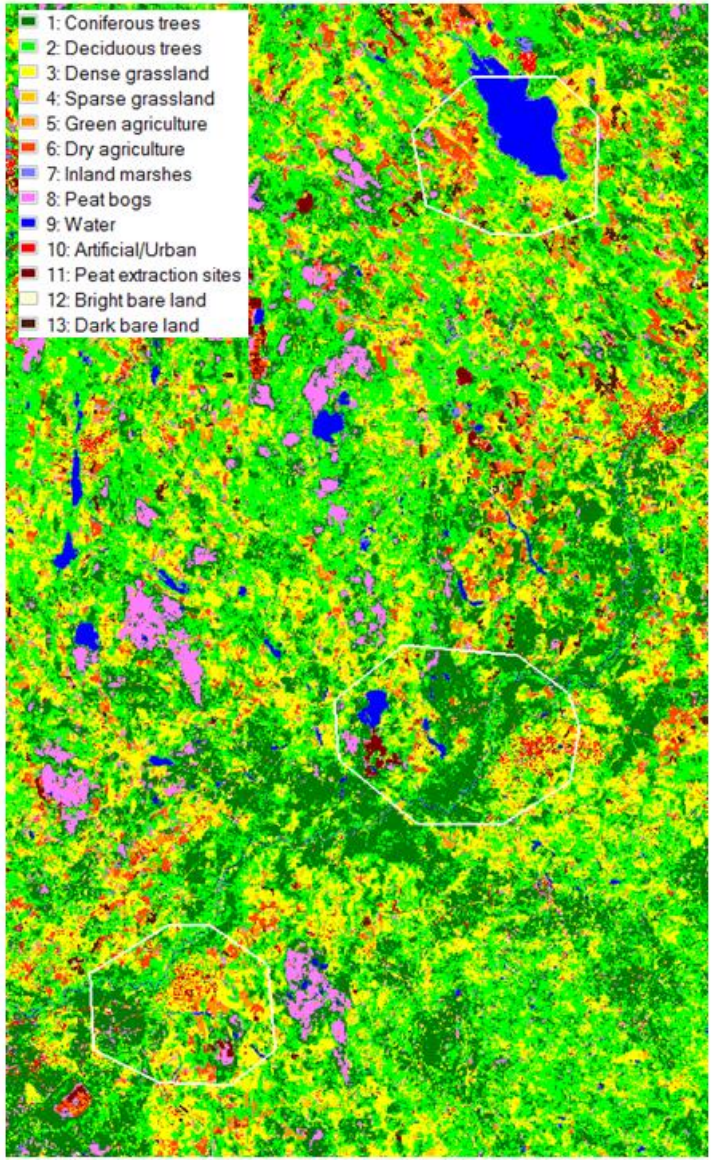
SVM score values for the assessment and replacement of possible outliers





Development of classification algorithm

Classification of LC for all pilot territories from 14.08.2015. Sentinel-2 data using SVM classifier



INSTITUTE FOR ENVIRONMENTAL SOLUTIONS

SENTIGRASS

Assessment of Grassland Quality and Quantity Parameters and Management Activities Using Sentinel-1&2 data
2016-2018

The project is aimed to explore the capability of Sentinel-1 radar and Sentinel-2 optical data use and fusion for the assessment of grassland management activities and quantitative/qualitative parameters, thus moving towards the development of a multifunctional grassland surveillance and monitoring tool.

Collaboration with Tartu Observatory

User needs analysis

INSTITUTE FOR ENVIRONMENTAL SOLUTIONS

List of potential end-users:

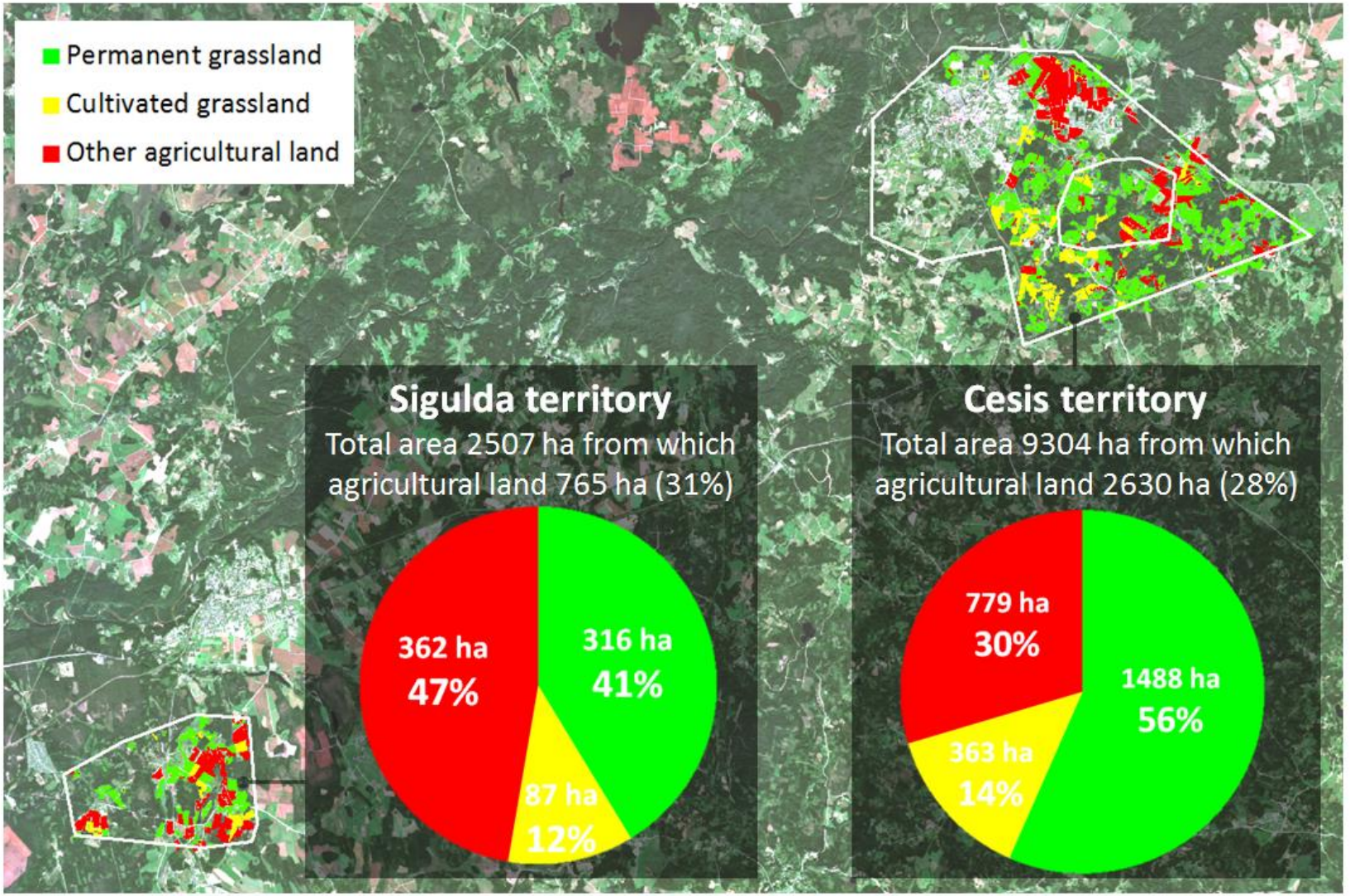
- The Rural Support Service
- The Natural Conservation Agency (grassland experts)
- The Latvian Fund of Nature
- The Latvian Rural Advisory and Training Center
- Local municipalities and regional institutions

Target data products and accuracy:

- Mapping of grasslands (>80%)
- Ploughing detection (>80%)
- Moving detection (>80%)
- Grazing detection (not set)
- Grassland biomass (RMSE <25% of mean biomass value)
- Mapping of invasive/expansive species (>80% for HR remote sensing data)
- Mapping of shrubs/trees (>80%)
- Biodiversity assessment (not set)

Pilot territories

Two pilot territories – Sigulda and Cesis



Data acquisition

Acquisition of extensive data sets for both pilot territories:

- 25 Sentinel-1 SAR
- 7 Sentinel-2 MS scenes
- Airborne hyperspectral, LiDAR and high resolution orthophoto data from 2 dates
- Weekly monitoring information from 122 grassland polygons
- 42 biomass samples
- reference maps of invasive/expansive species, species composition
- Forest and Agricultural land data

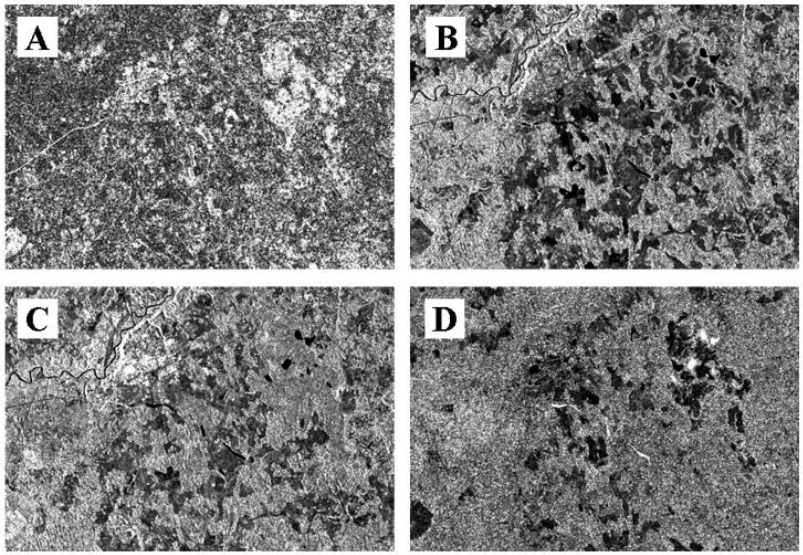


Figure 1.1. Sample images from the data stack covering study area around Sigulda. (*a*) Coherence. (*b*) VH backscattering coefficient. (*c*) VV backscattering coefficient. (*d*) VH/VV ratio. Source: RON160 September 23 acquisition. Coherence was calculated for September 23 and October 5 pair.

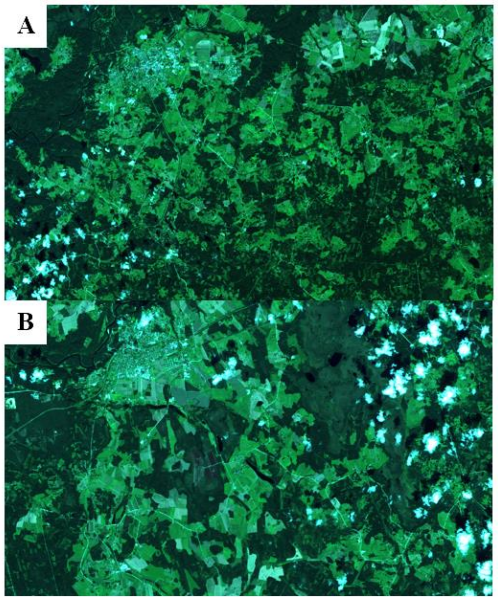


Figure 1.2. Cesis (A) and Sigulda (B) pilot territories in Sentinel-2A MSI data (25.08.2016)

INSTITUTE FOR ENVIRONMENTAL SOLUTIONS

SENTIBALT

Simulating Performance of ESA Future Satellites for Water Quality of the Baltic Sea

The project is aimed to develop improved remote sensing algorithms and methods suitable for the Baltic Sea conditions and estimate their potential accuracy for different concentration ranges of optically active substances.

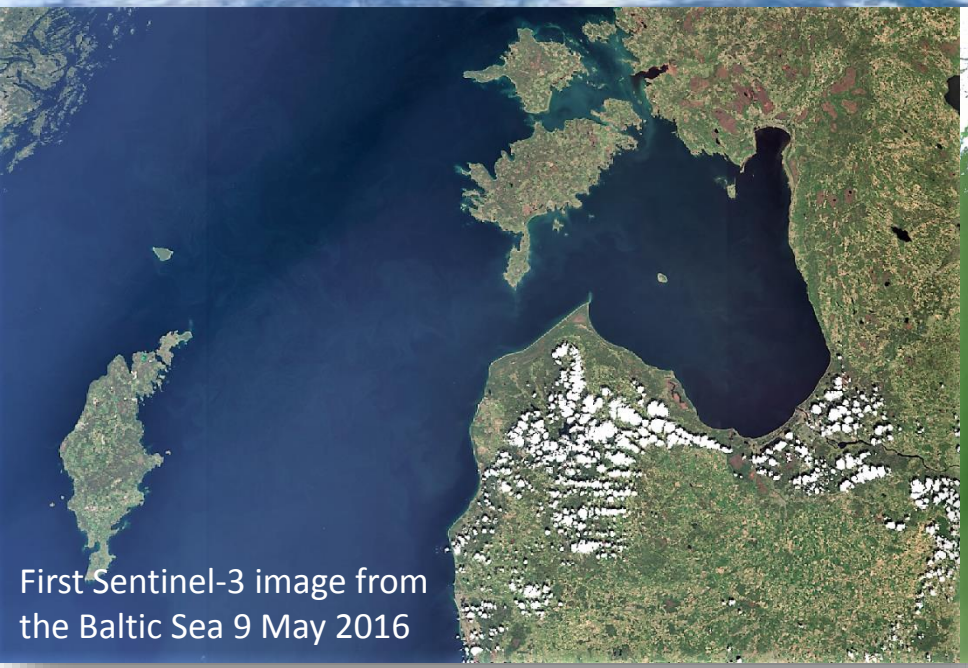
Collaboration with Estonian Marine Institute

INSTITUTE FOR ENVIRONMENTAL SOLUTIONS

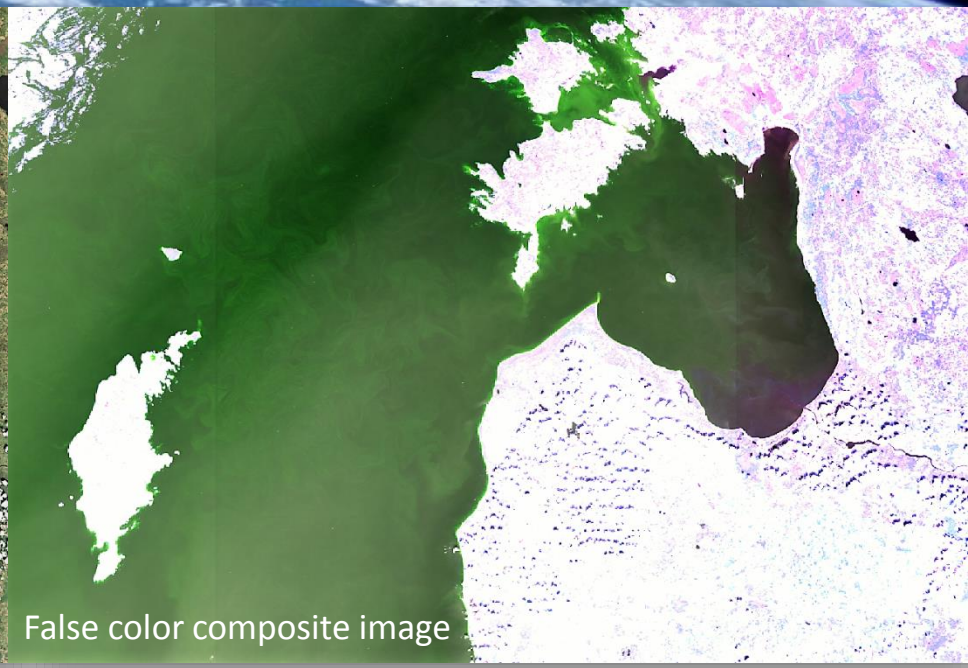
Motivation

ESA Sentinel-3 was launched
16 February 2016

http://www.esa.int/



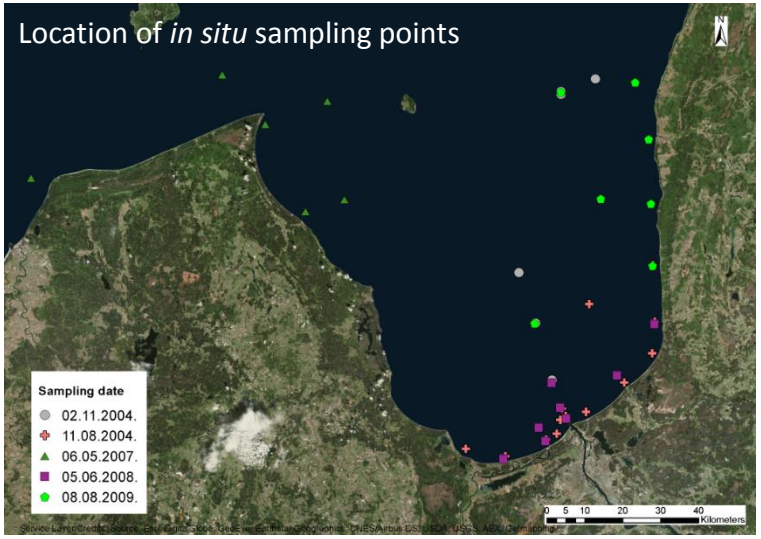
First Sentinel-3 image from the Baltic Sea 9 May 2016

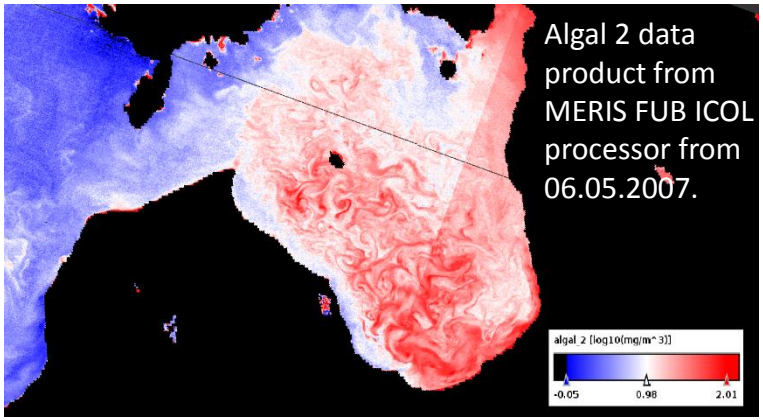


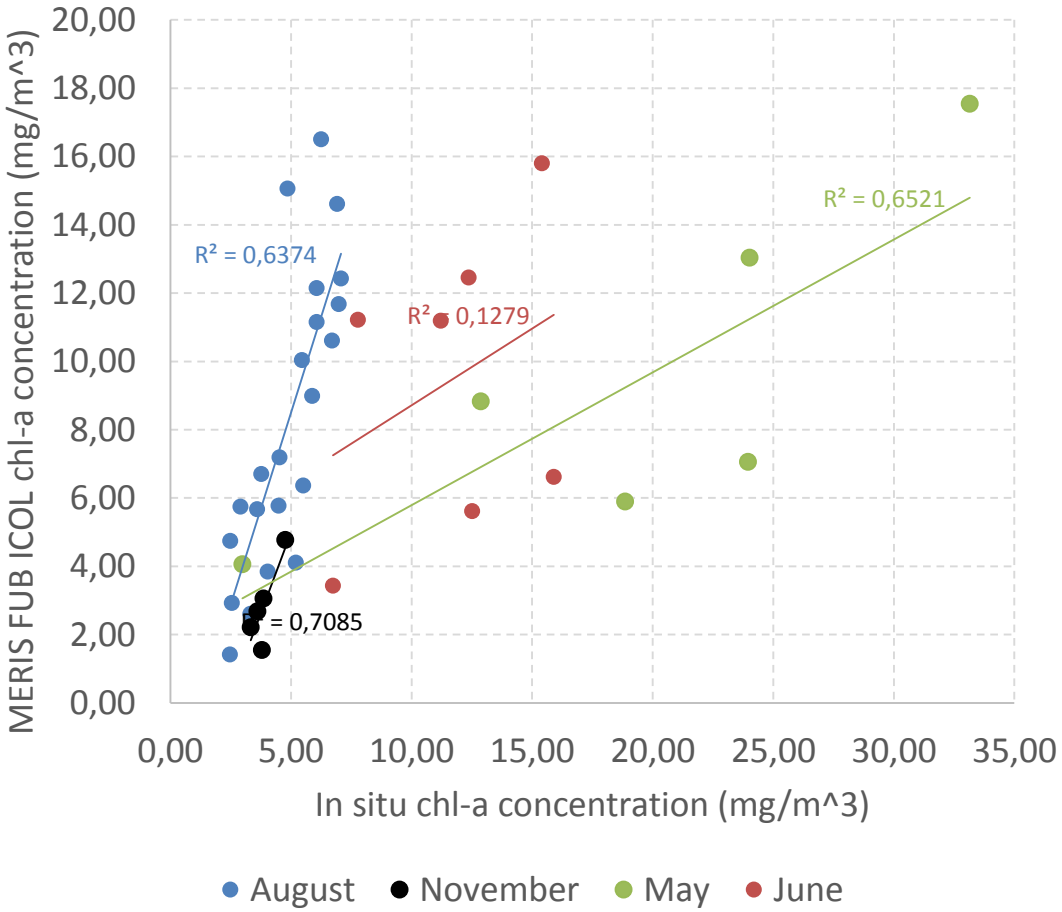
False color composite image

Testing MERIS processors with archive data

Location of *in situ* sampling points from five cloud free MERIS dates and correlation (R^2) between *in situ* sampling and best performing MERIS FUB ICOL results.







Data acquisition campaigns

Four simultaneous *in situ* and airborne data acquisition campaigns were performed:

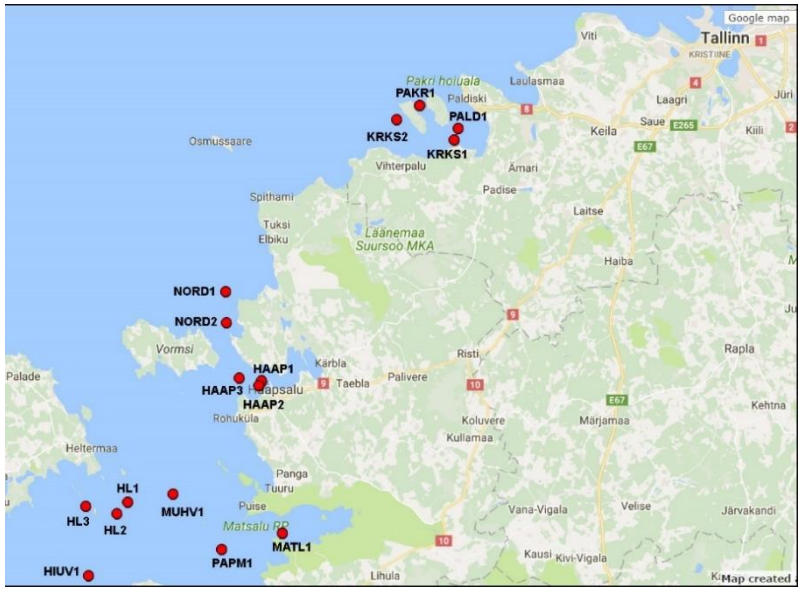
- 11.08.2015. the Gulf of Riga (Latvia) – 10 sampling points
- 12.08.2015. the Gulf of Riga (Latvia) – 8 sampling points
- 31.05.2016. Estonian coastal waters – 8 sampling points
- 14.09.2016. Estonian coastal waters – 8 sampling points

Campaigns resulted in 34 *in situ* sampling points with airborne overpass.

The main limitation for optimal data acquisition was weather conditions.

Sampling points from 2015 in the Gulf of Riga

Sampling points from 2016 in Estonian coastal waters

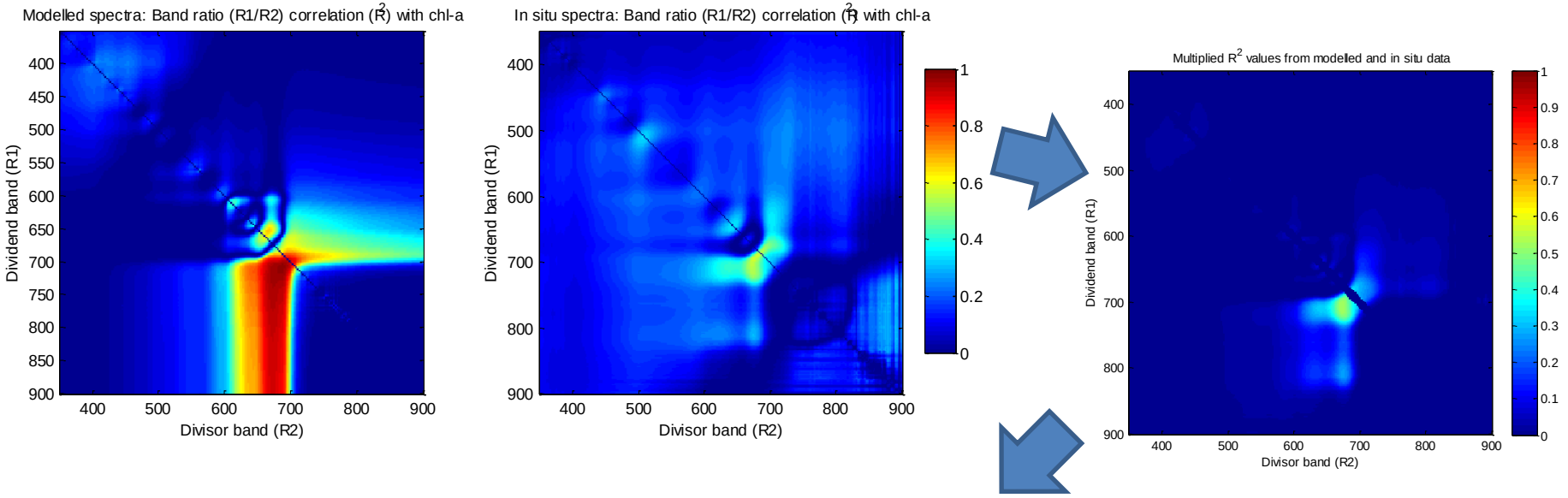


Testing and development of algorithms

Additional spectral data:

- 60 *in situ* sampling points from Estonian coastal waters (EMI);
- 15600 modelled spectra for optical properties characteristic for the Baltic Sea (FEI)

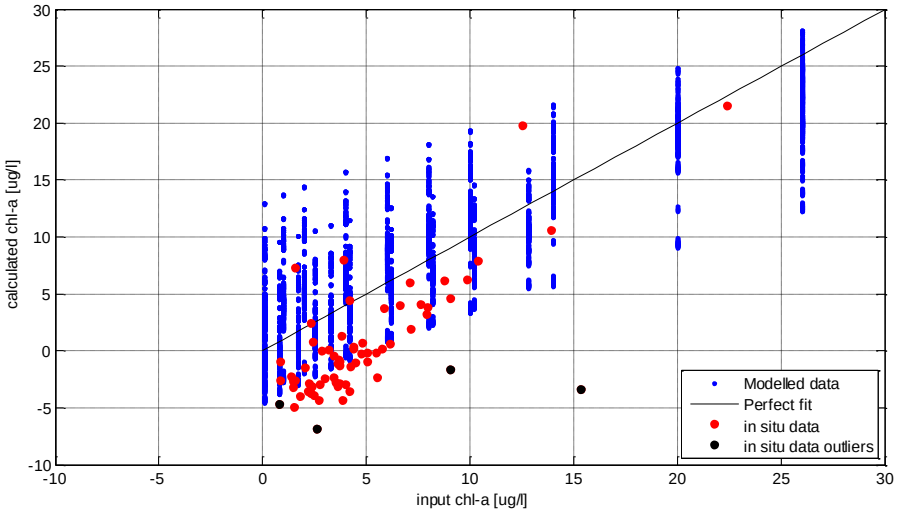
Testing of best performing band ratio algorithms for the Baltic Sea



Modelled data			In situ data			Modelled and in situ data			
R1 [nm]	R2 [nm]	R^2	R1 [nm]	R2 [nm]	R^2	R1 [nm]	R2 [nm]	R^2	R^2
707,5	687,5	**0,976**	692	676	**0,575**	702	674	**0,957**	**0,551**
705,0	687,5	**0,975**	690	678	**0,574**	702	672	**0,952**	**0,554**
710,0	687,5	**0,974**	694	674	**0,572**	706	672	**0,960**	**0,549**
707,5	685,0	**0,974**	690	680	**0,572**	706	674	**0,964**	**0,546**
710,0	685,0	**0,973**	692	678	**0,572**	700	674	**0,949**	**0,555**

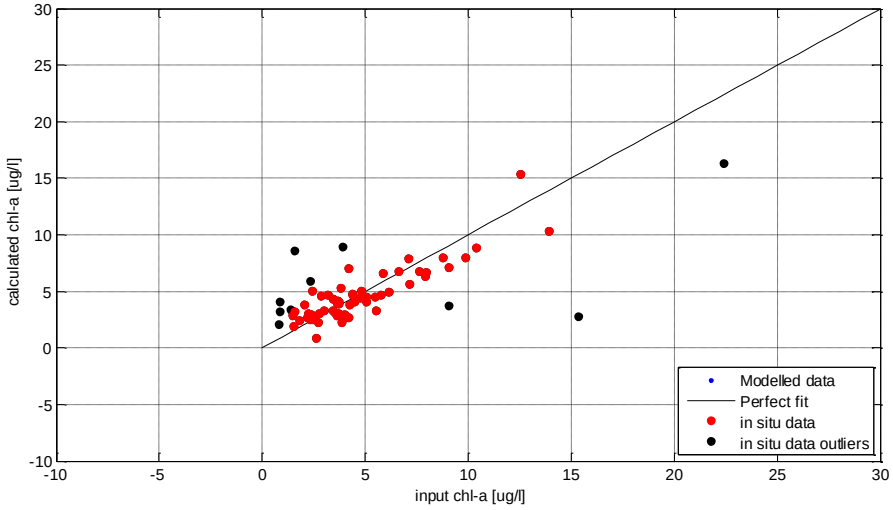
Testing and development of algorithms

Comparison of modelled and *in situ* spectral data using best performing two band ratio (702, 674 nm).



Modelled data (chl-a concentration <30 ug/l) is used for training

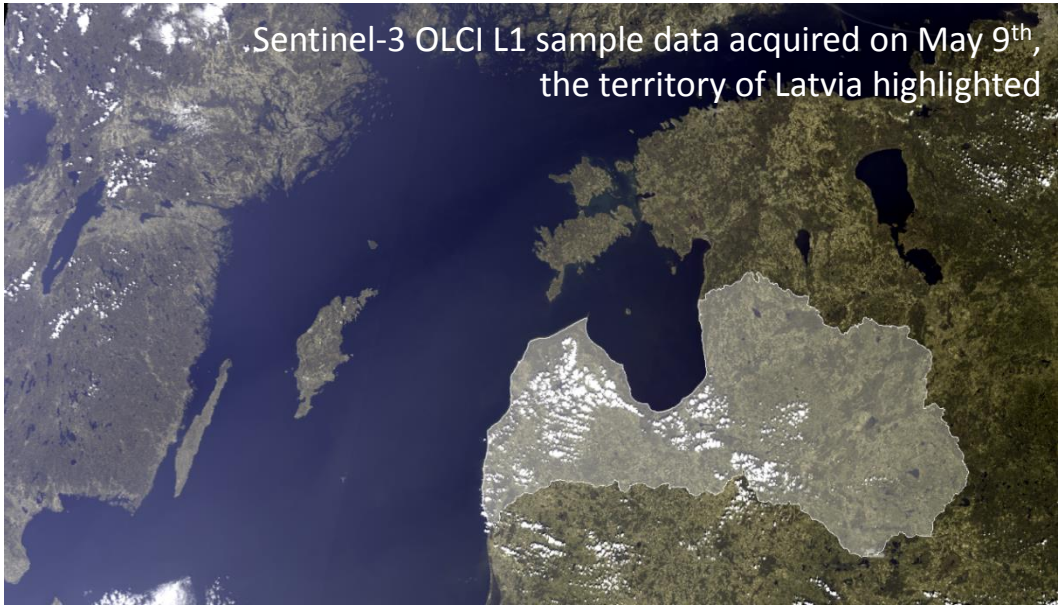
Performance of the model:
- modelled data: R^2 = 0.762, RMSE = 3.76 ug/l;
- *in situ* data: R^2 = 0.546, RMSE = 5.60 ug/l.

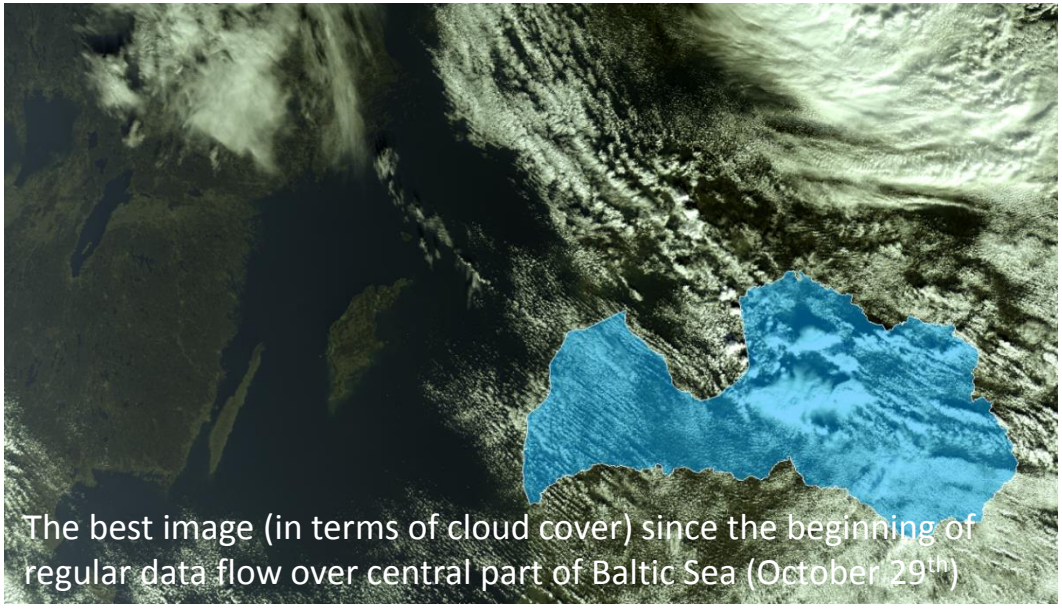


in situ data is used for training

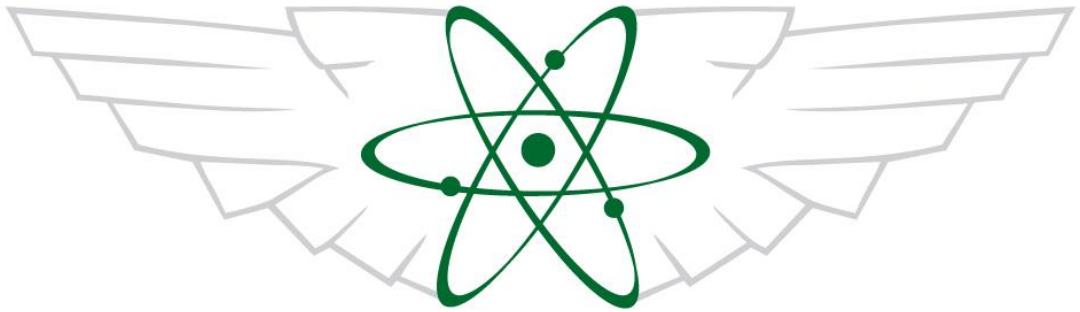
Performance of the model:
- all in situ points: R^2 = 0.546, RMSE = 2.53 ug/l;
- after removal of outiers: R^2 = 0.775, RMSE = 1.27 ug/l.

Sentinel-3 OLCI data availability





INSTITUTE FOR ENVIRONMENTAL SOLUTIONS



Institute for Environmental Solutions
Dainis Jakovels, Technical Project Manager of PECS projects
dainis.jakovels@videsinstituts.lv, +371 29116741