
LIFE
Viva
Grass

Assessment of permanent grasslands in Latvia using spectral remote sensing techniques

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Motivation

Development of integrated planning tool for sustainable grassland management

GIS (geographic information system) based environment with incorporated ecosystem services as well as socio-economic parameters where grassland map, overgroth with shrubs and trees, spreadth of invasive species (*Heracleum sosnowskyi*) and grass biomass are required input layers.

Pilot territory

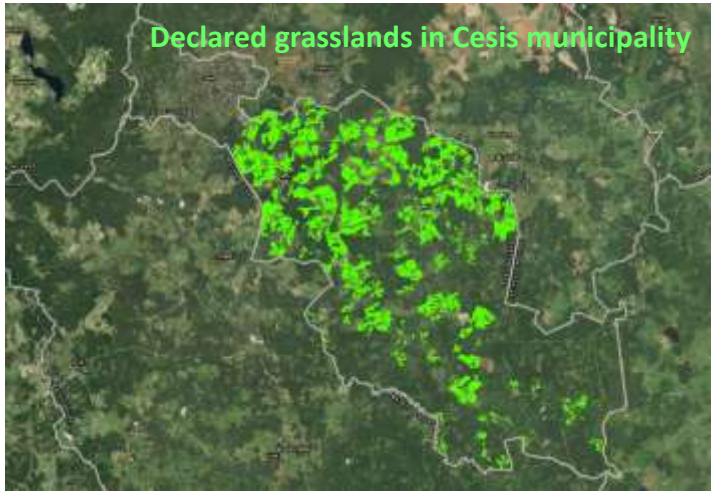
Cesis municipality in Latvia

Agricultural land / grassland statistics in Latvia

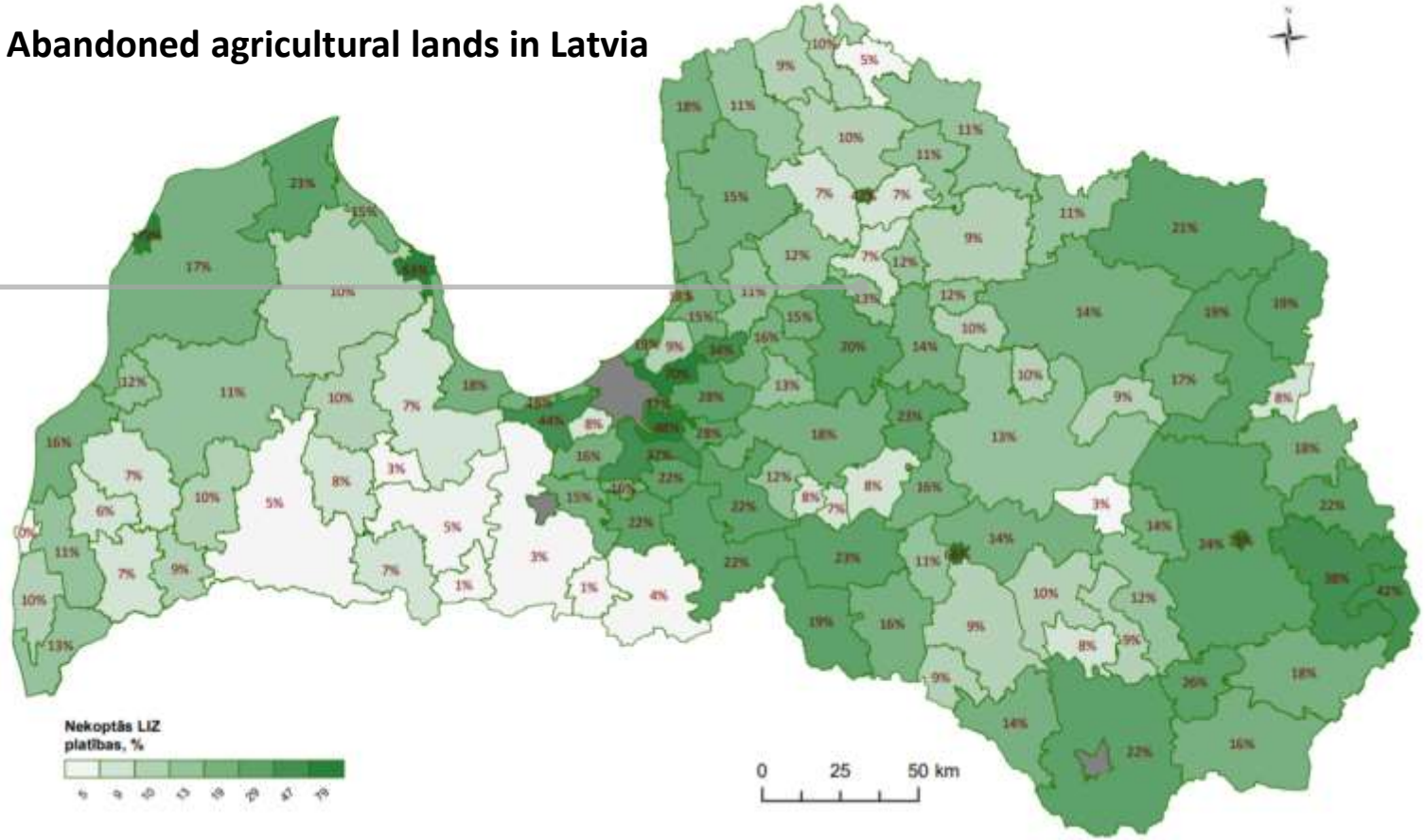
- Total area: 645 kha (100%)
- Agricultural land: 1796 kha (27%)
  - Grasslands: 651 kha (36%)

in Cesis municipality (pilot site)

- Total area: 17,1 kha (100%)
- Agricultural land: 3,6 kha (21%)
  - Grasslands: 2,6 kha (72%)



Abandoned agricultural lands in Latvia

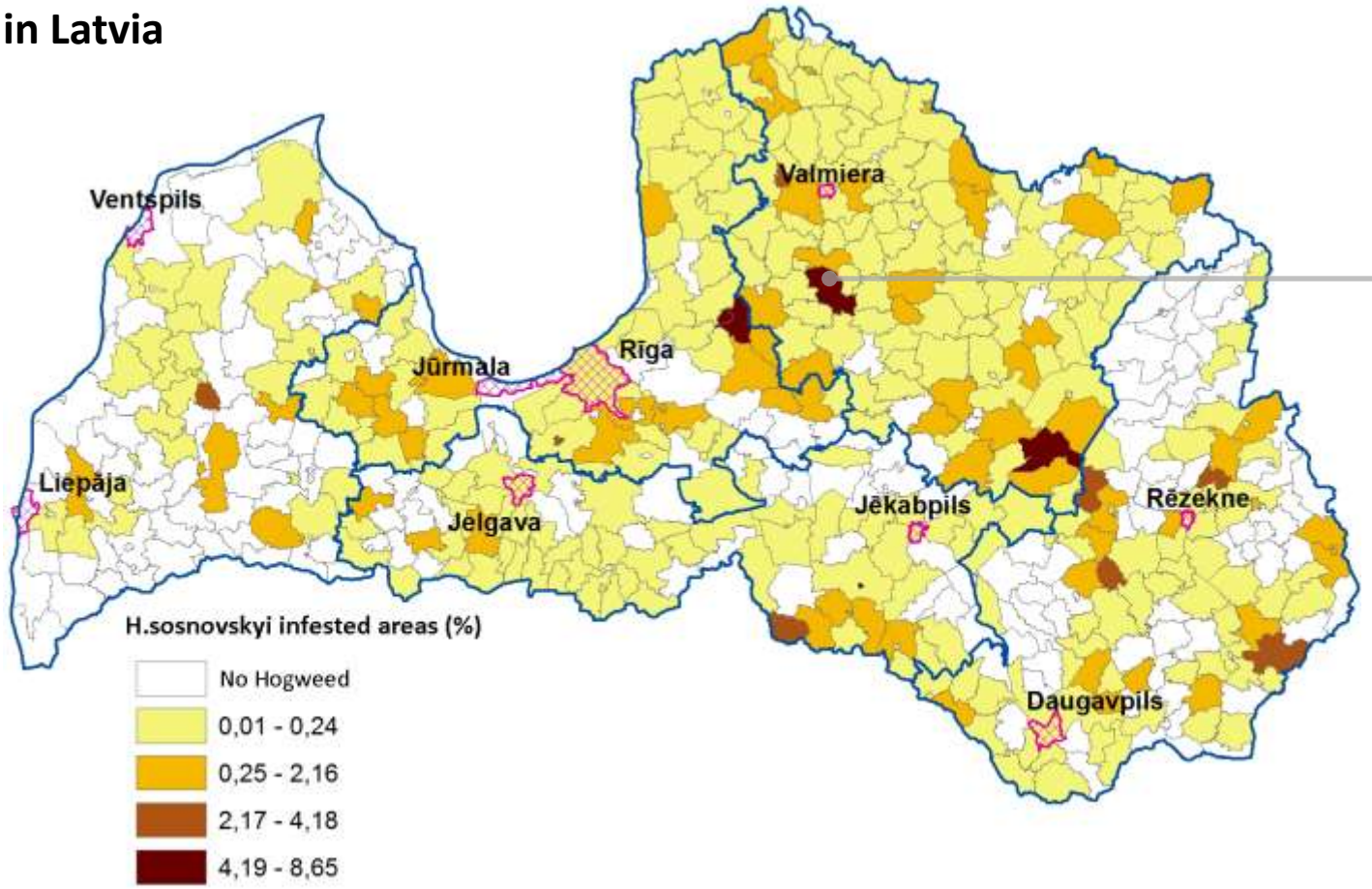


Rural Support Service data (2016) representing percentage of abandoned agricultural land per municipality
http://www.lad.gov.lv/files/liz_export_2016.pdf

Pilot territory

Cesis municipality in Latvia

Sosnowksy's hogweed (*Heracleum sosnowskyi*) infested areas in Latvia



Cesis municipality (pilot site)

http://www.vaad.gov.lv/sakums/informacija-sabiedribai/par-latviju-bez-latvaniem/paveiktais-sosnovska-latvana-izplatibas-ierobezosana.aspx

Remote sensing data acquisition

Airborne Surveillance and Environmental Monitoring System

ARSENAL

STA system
with standard colour and thermal vision modes

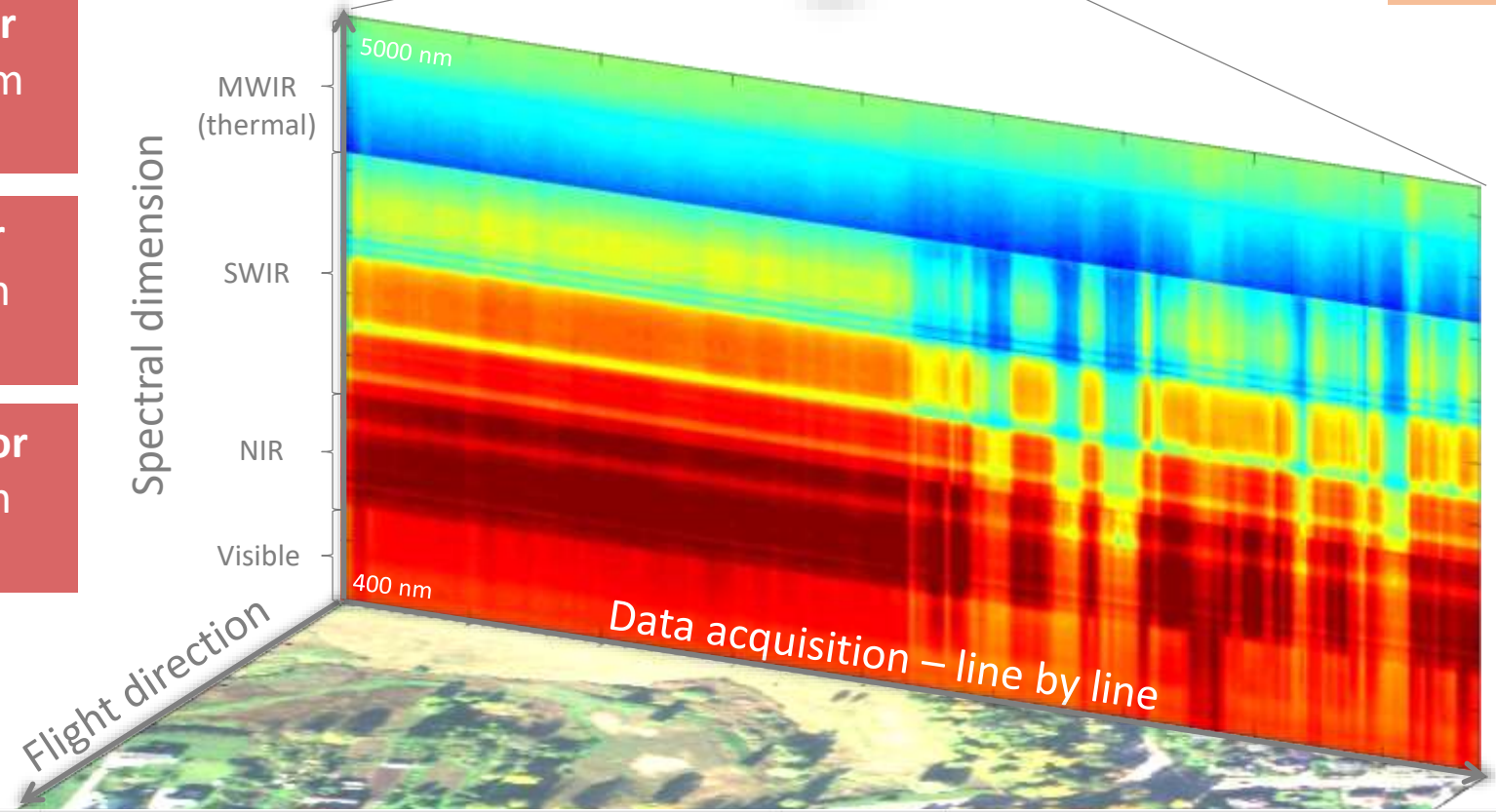
High resolution
60M pix RGB camera

Spectral sensors

MWIR sensor
3000-5000 nm
64 bands

SWIR sensor
950-2450 nm
100 bands

VIS-NIR sensor
380-1050 nm
144 bands



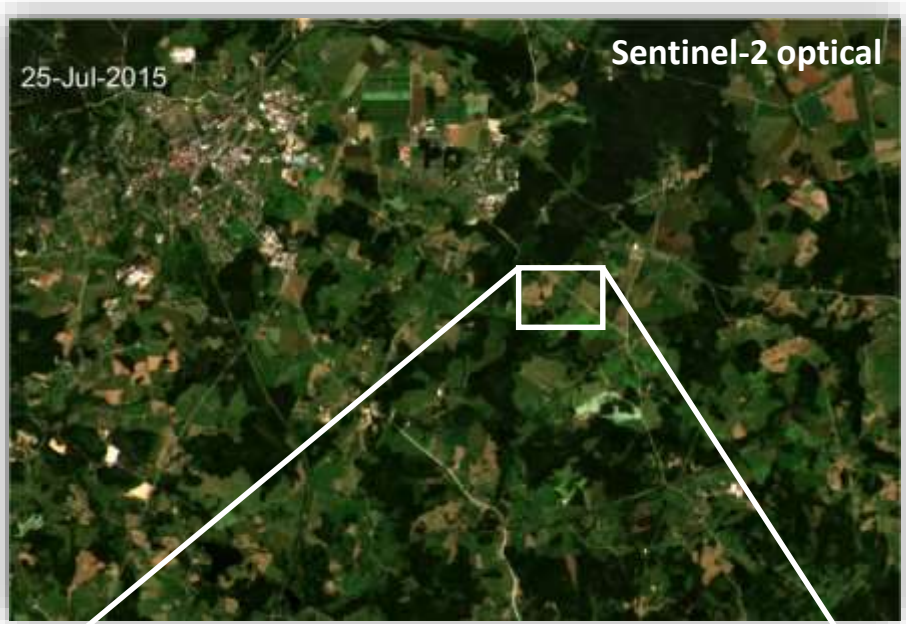
Terrestrial LIDAR

Broadband

Thermal sensor
3800-4800 nm

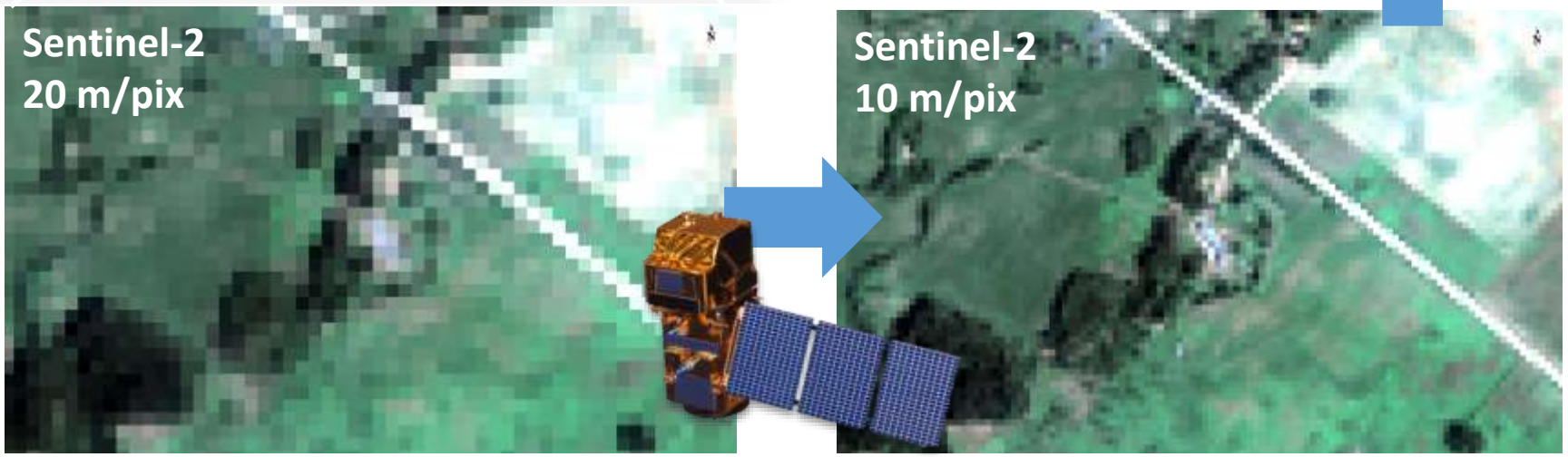
Ultraviolet sensor
280-375 nm

Sentinel-2 satellite data as a complementary data source

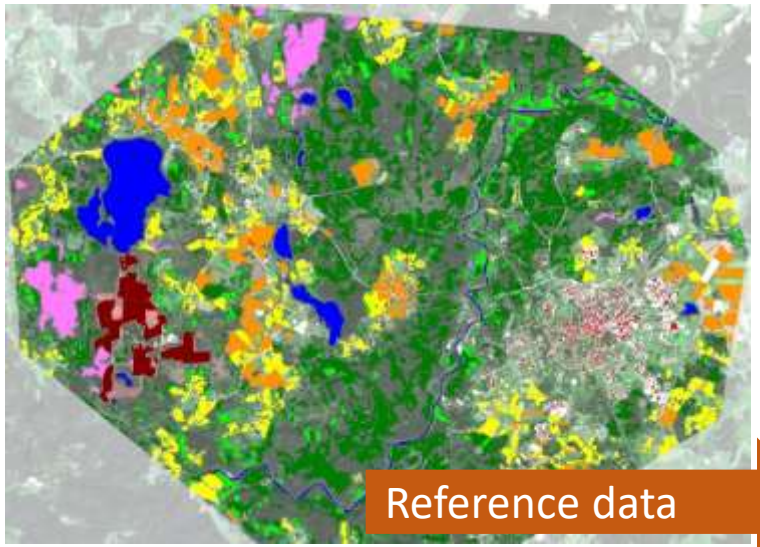


Dates:

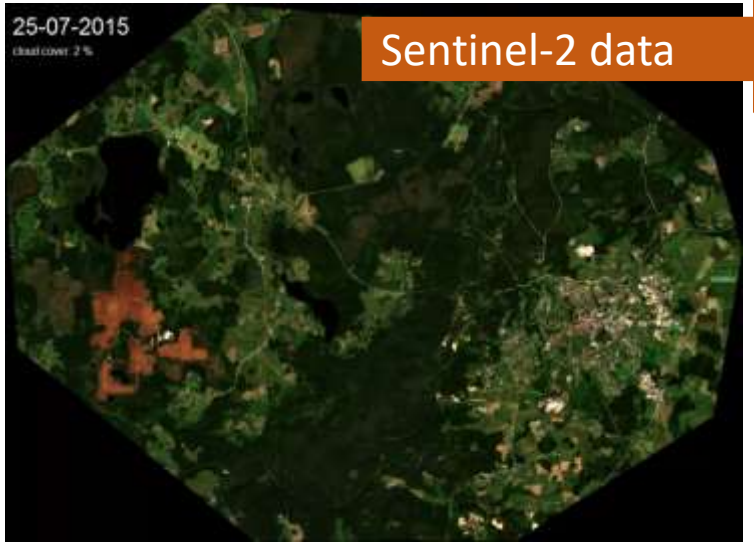
25-07-2015
04-08-2015
14-08-2015
21-08-2015
24-08-2015
07-04-2016
27-04-2016
30-04-2016
07-05-2016
06-07-2016
25-08-2016
14-09-2016
05-05-2017
22-05-2017
25-05-2017
30-08-2017
29-09-2017
22-10-2017



Mapping of grasslands from Sentinel-2 satellite data



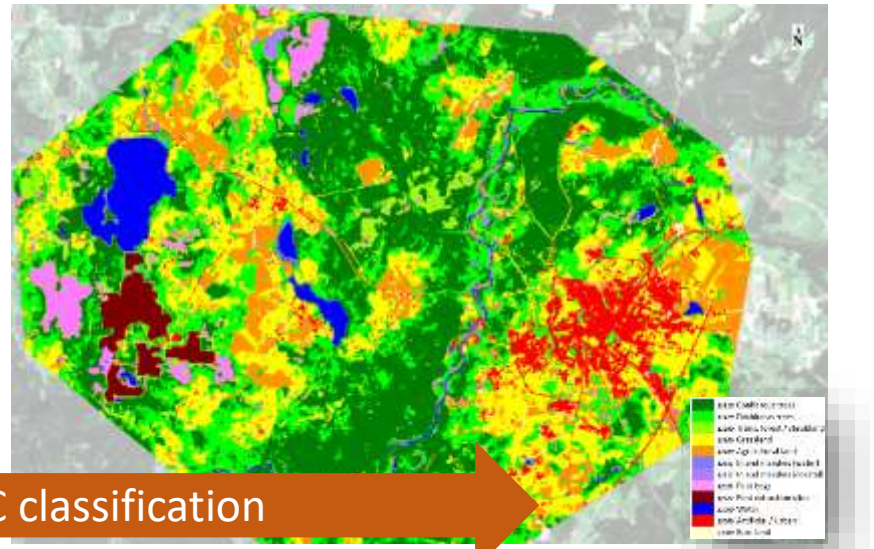
Reference data



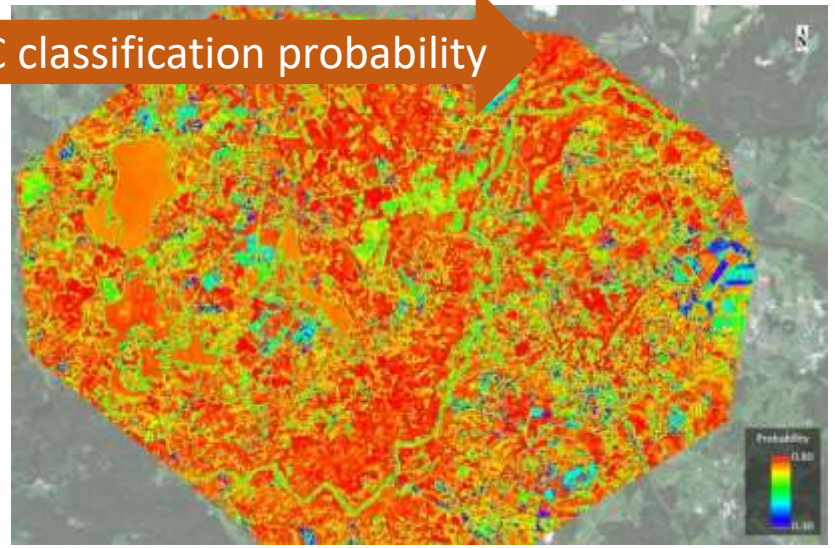
Sentinel-2 data

LC classification algorithm

- supervised
- automated
- class-by-class approach
- based on SVM classifier applied to each scene
- individual decision rules for each class
- annual 20 m/pix LC classification as an output



LC classification

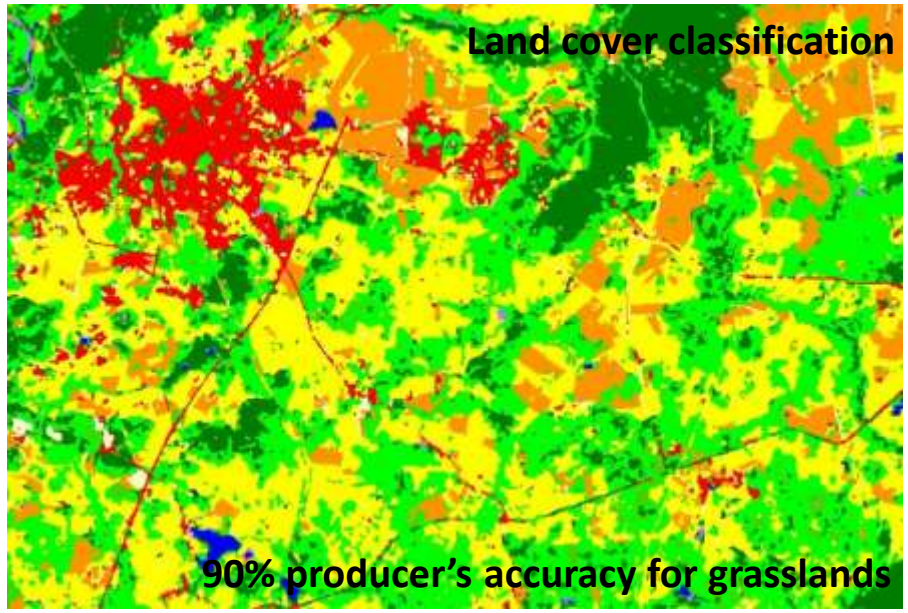


LC classification probability

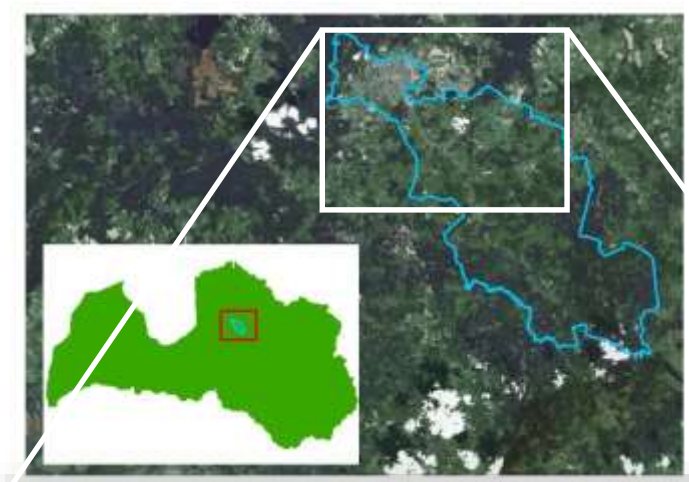
Mapping of grasslands from Sentinel-2 satellite data

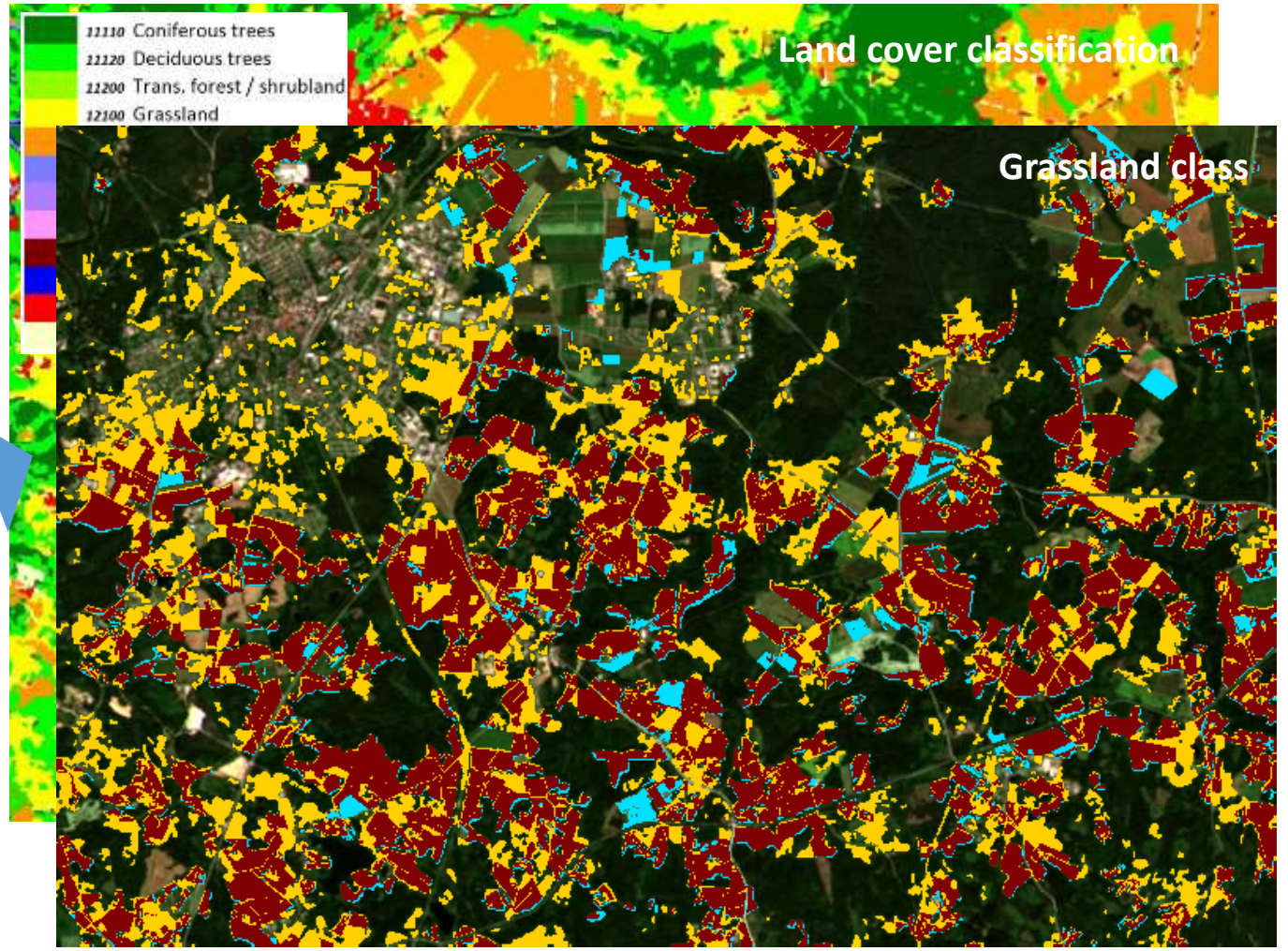
Confusion matrix

	11110	11120	11200	12100	12200	12311	12312	12321	12322	21000	22000	23000		*Producer's accuracy*
11110 Coniferous trees	83571	11816	738	22	39	0	7	29	0	0	22	0	96244	92%
11120 Deciduous trees	3298	39337	213	47	44	0	11	1	0	0	2	0	42953	92%
11200 Trans. forest / shrubland	0	0	0	0	0	0	0	0	0	0	0	0	0	No ref. data
12100 Grassland	57	226	506	60869	2220	6	1024	1	2	0	47	131	65089	94%
12200 Agricultural land	50	212	976	1608	100032	1	1413	0	0	0	96	1156	105544	95%
12311 Inland marshes (water)	0	0	0	0	0	0	0	0	0	0	0	0	0	No ref. data
12312 Inland marshes (coastal)	159	447	306	107	71	836	4974	149	0	3	3	2	7057	70%
12321 Peat bogs	1131	40	2425	19	49	0	44	13151	28	4	0	0	16891	78%
12322 Peat extraction sites	0	3	77	0	2	0	15	0	8403	0	1	0	8501	99%
21000 Water	13	7	86	72	204	699	308	0	0	91011	18	1	92419	98%
22000 Artificial / Urban	20	14	93	419	328	1	48	0	49	0	6136	324	7432	83%
23000 Bare land	0	1	6	0	1	1	0	0	0	0	2	496	507	98%



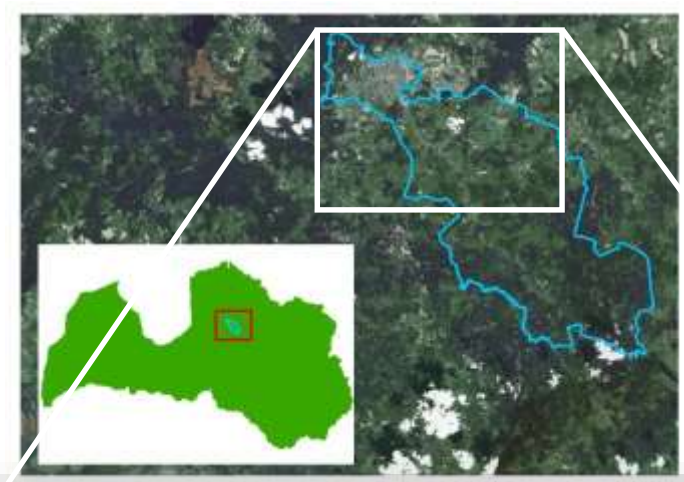
Mapping of grasslands from Sentinel-2 satellite data

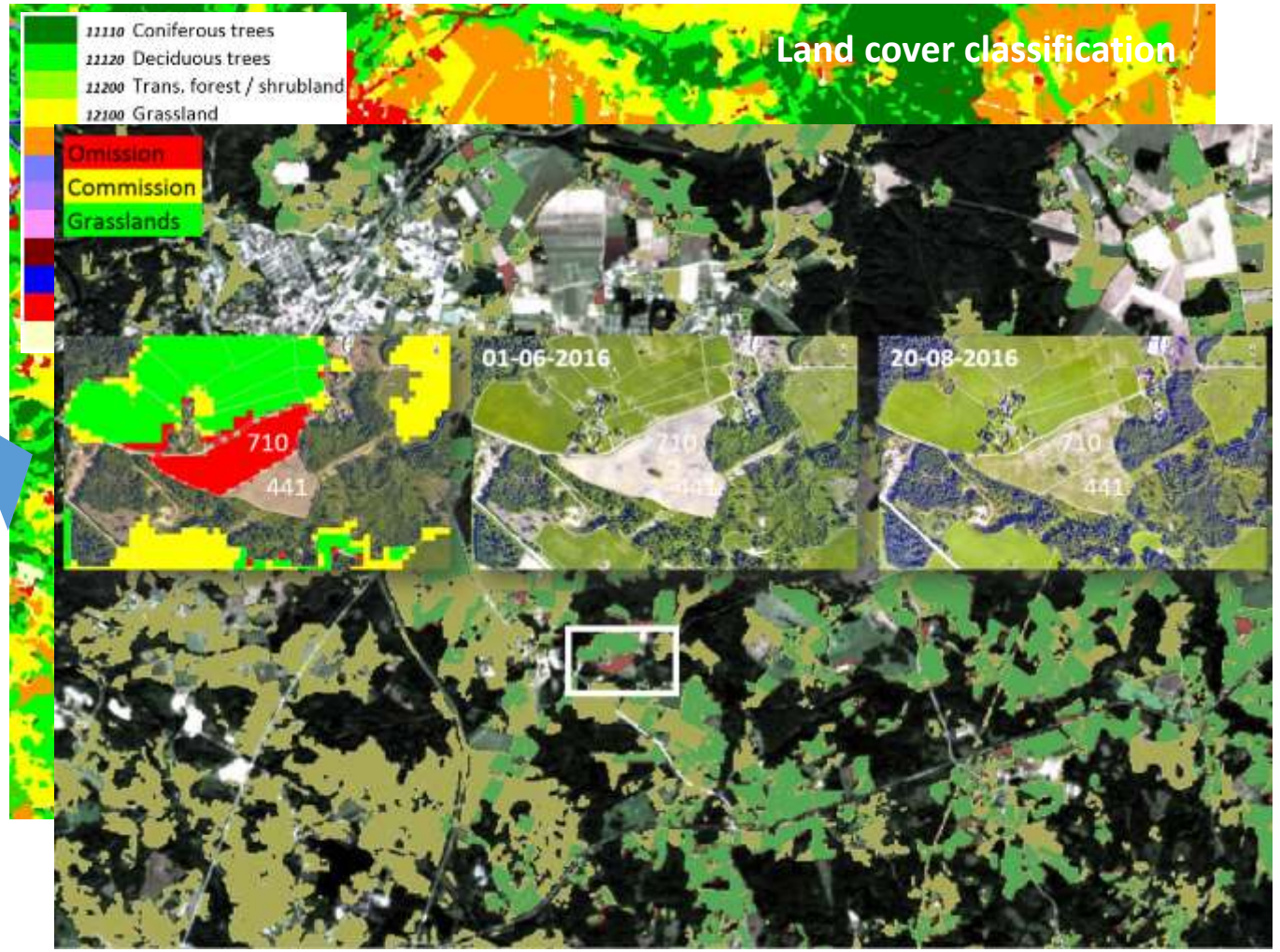




Legend: declared grasslands, non-declared grasslands, grasslands where ploughing has occurred

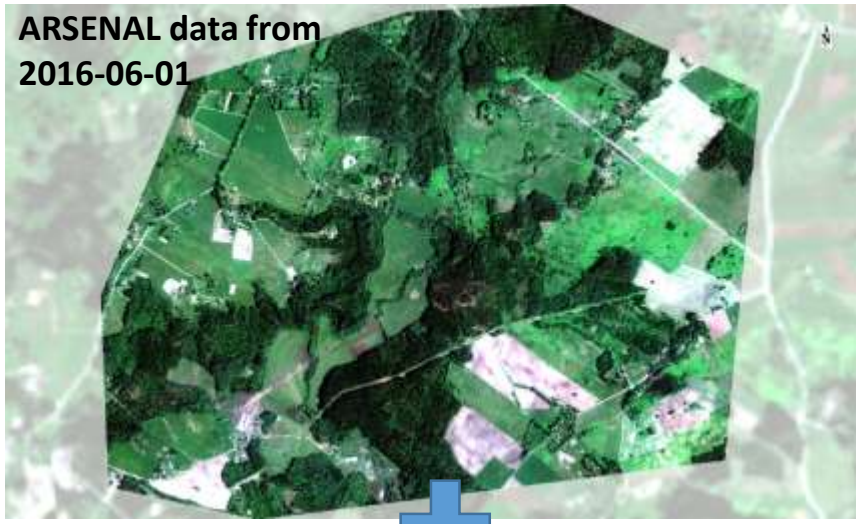
Mapping of grasslands from Sentinel-2 satellite data



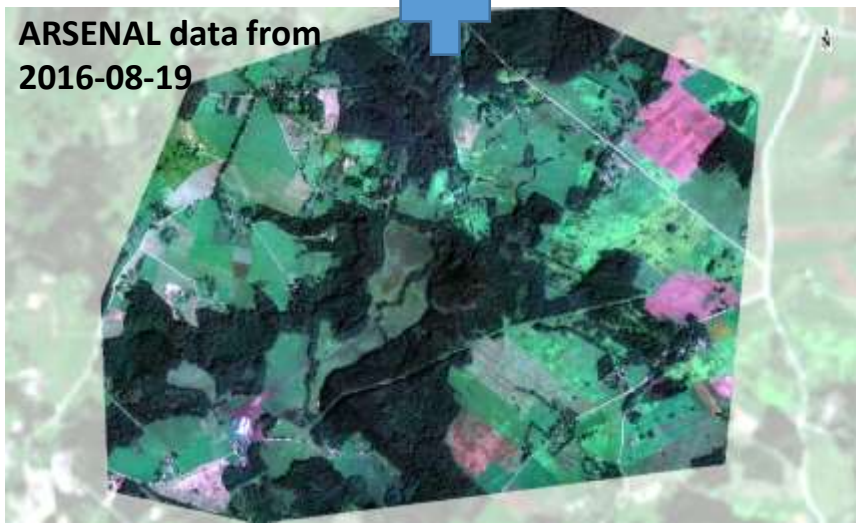


Mapping of Sosnowsky's hogweed (*Heracleum sosnowskyi)*

ARSENAL data from 2016-06-01



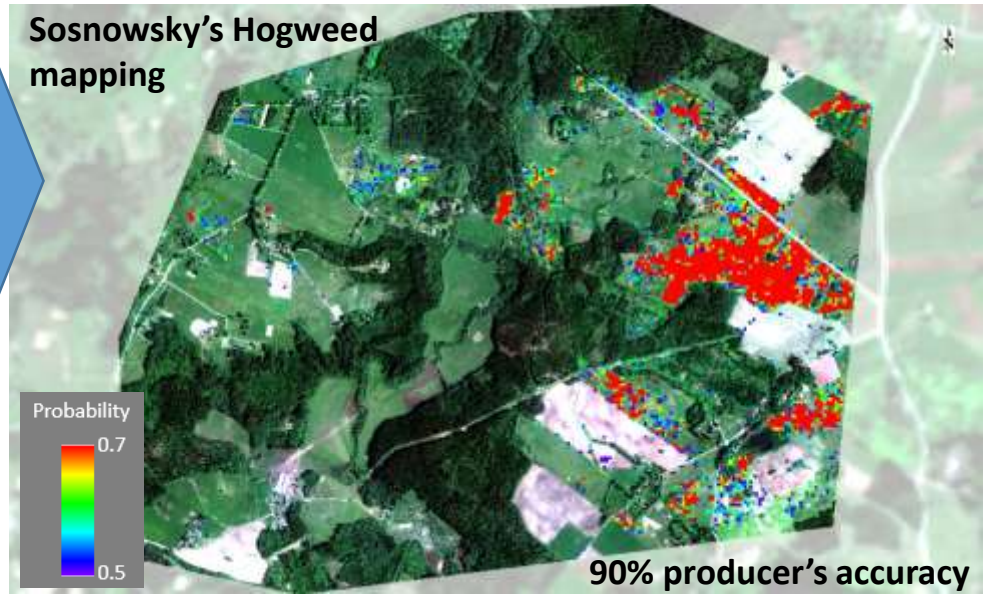
ARSENAL data from 2016-08-19



Supervised classification approach based on SVM classifier

Sosnowsky's Hogweed near Cesis

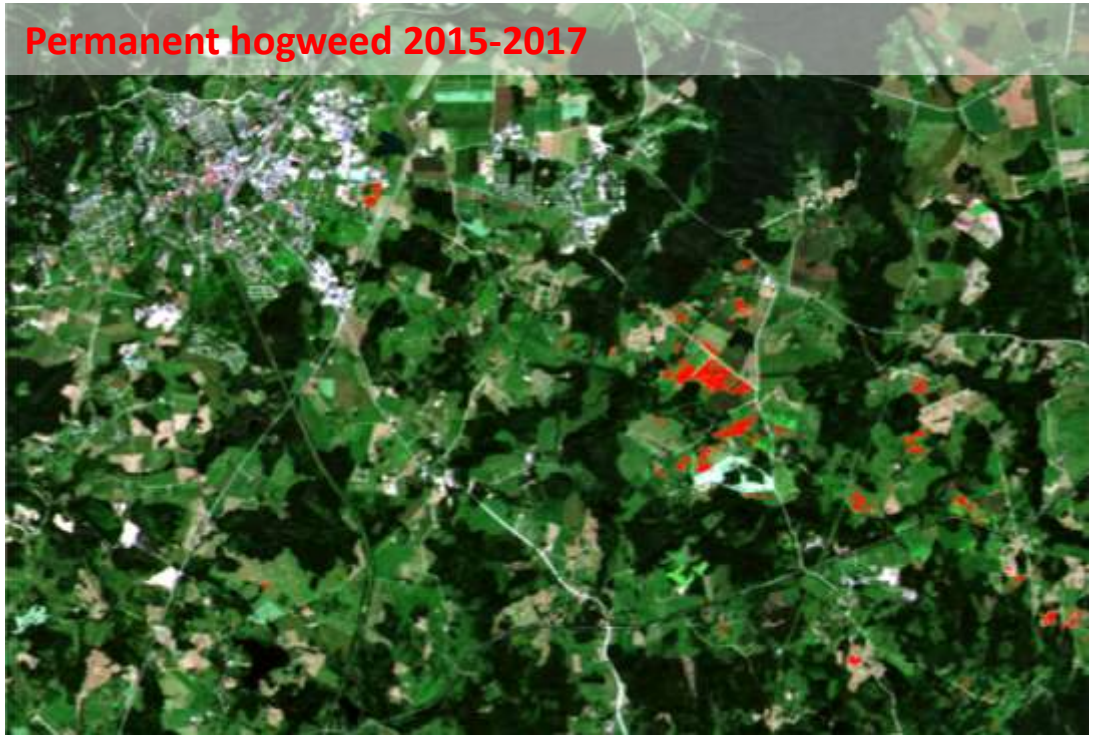
Sosnowsky's Hogweed mapping



90% producer's accuracy

Mapping of Sosnowsky's hogweed (*Heracleum sosnowskyi)*

Sentinel-2 satellite spectral data



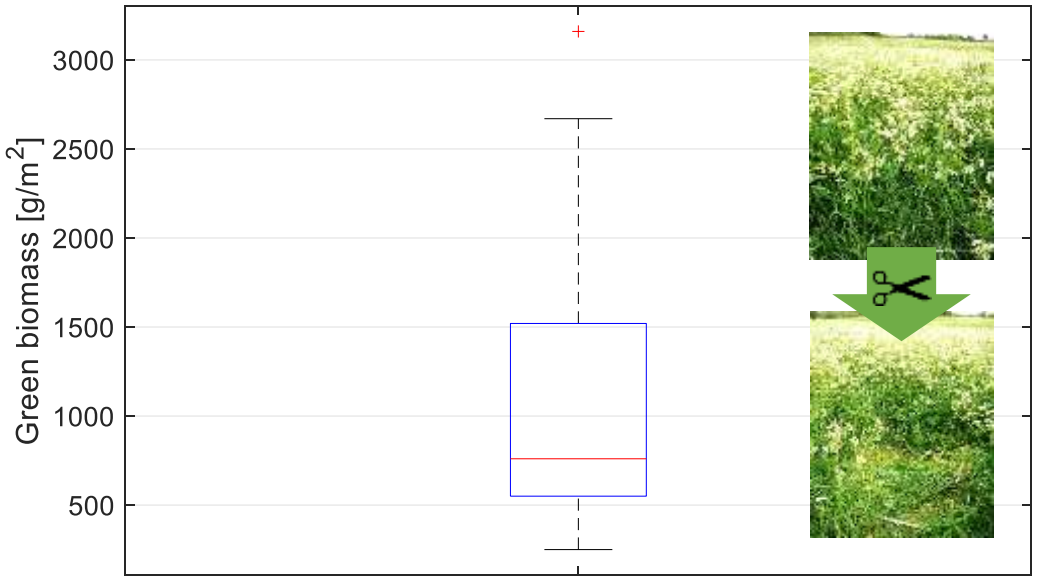
High accuracy (~90%) was achieved using temporal data from 2015-2017
Limited to relatively large hogweed stands due to spatial resolution (20 m/pix) of the data

Assessment of green grass biomass

Acquired in situ biomass values and corresponding spectra

In situ data

29 (of total 33) samples during June 2016



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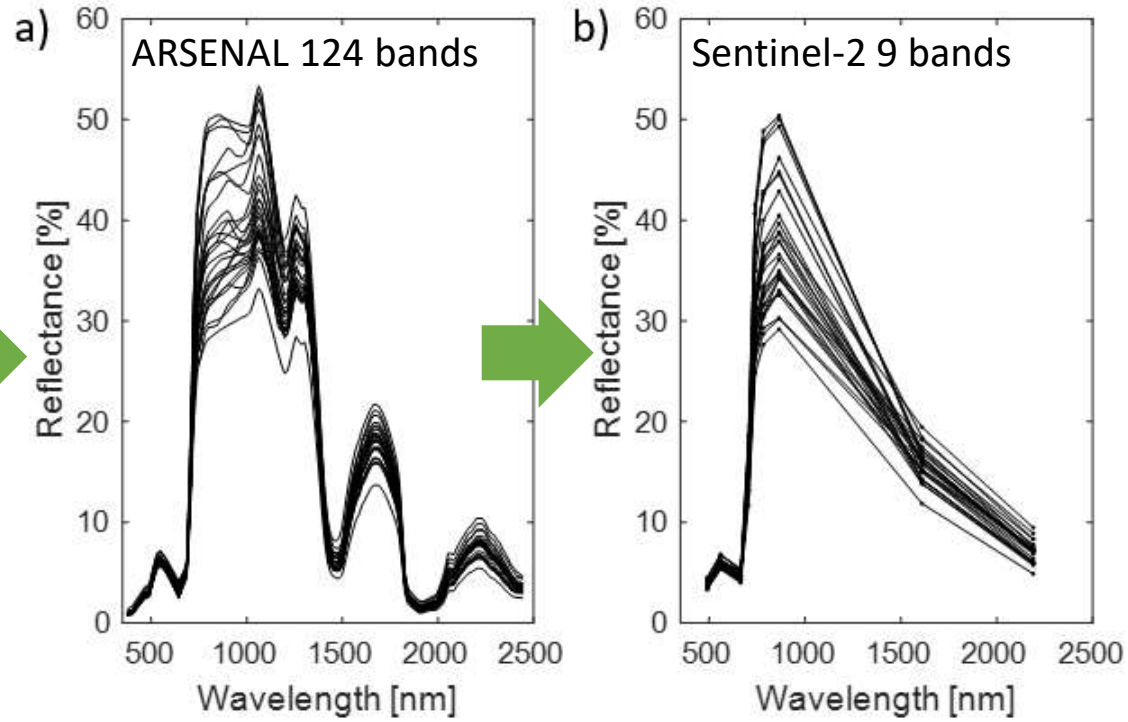
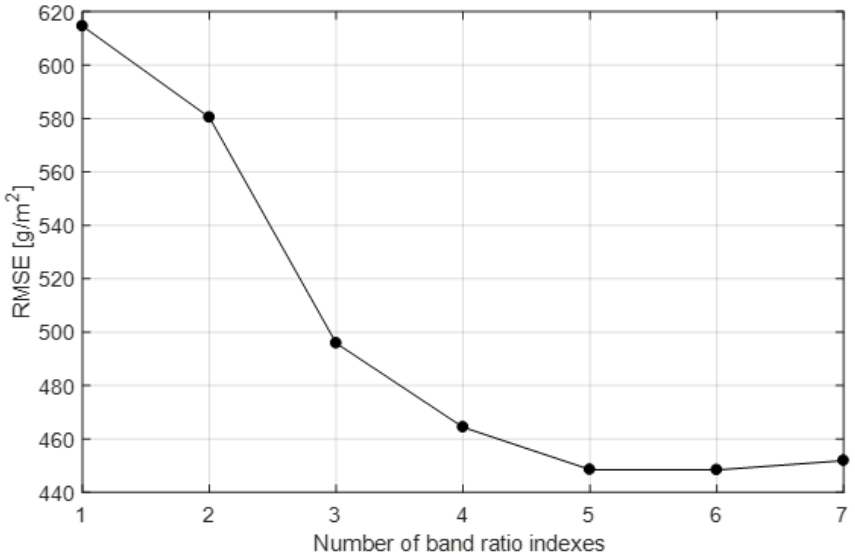
Airborne data (01-06-2016)



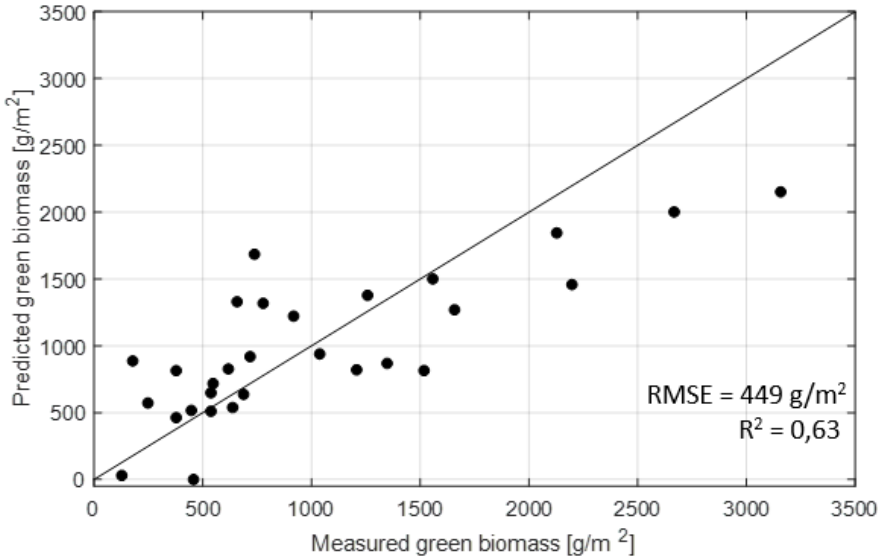
Assessment of green grass biomass

Stepwise approach for construction of linear regression model

a) Performance change by adding new variables



b) Performance of model with 5 band ratio indexes



Spectral bands used in the best performing five band ratio (B1/B2) linear model

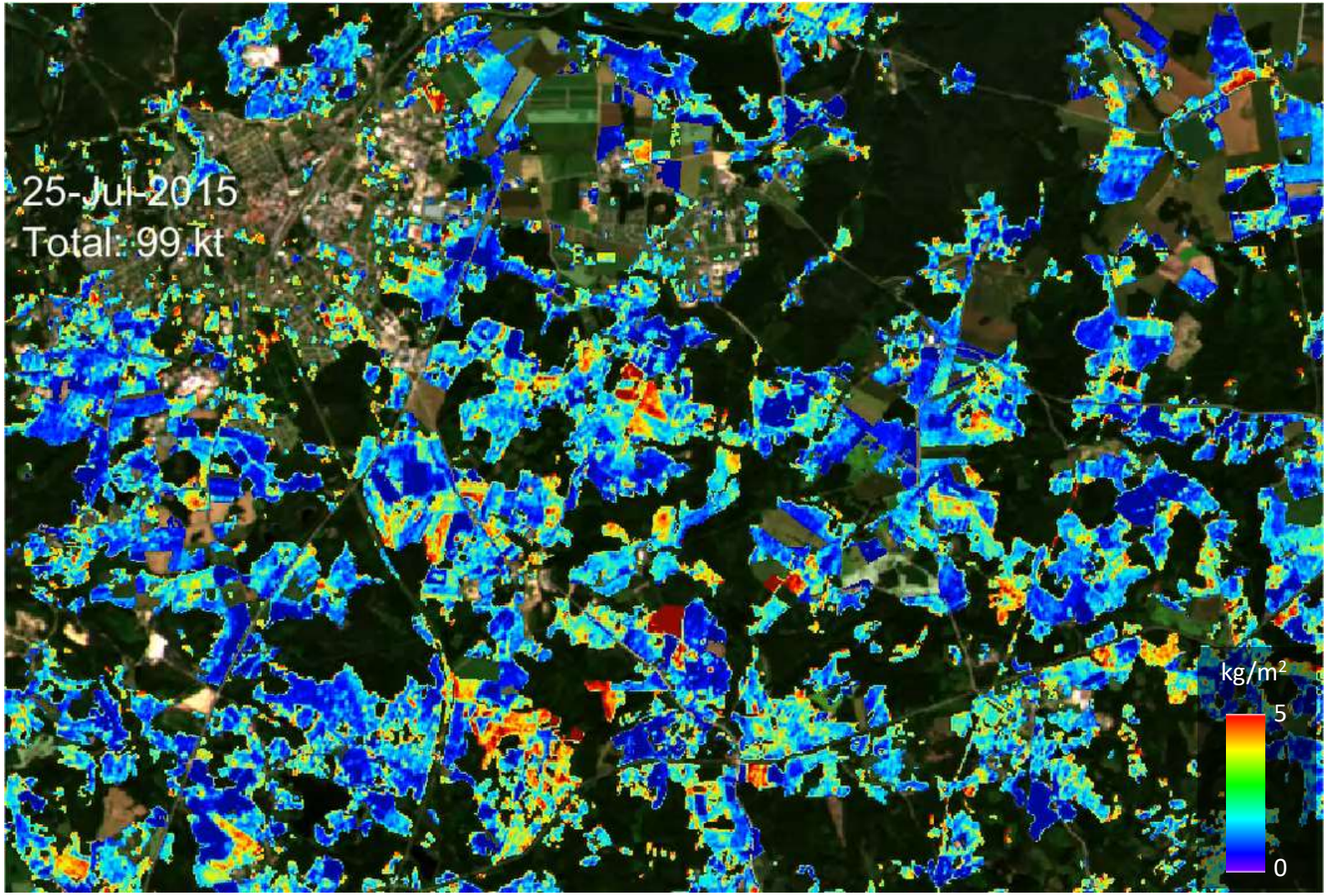
Iteration	B1 Number	Wavelength [nm]	Spectral range	B2 Number	Wavelength [nm]	Spectral range
1	11	856	NIR	44	1895	SWIR
2	90	4719	MWIR	63	3031	MWIR
3	10	810	NIR	70	3469	MWIR
4	25	1325	SWIR	74	3719	MWIR
5	65	3156	MWIR	53	2165	SWIR

Mapping of grasslands and assessment of green grass biomass

Colour variation of classified grasslands from available Sentinel-2 scenes

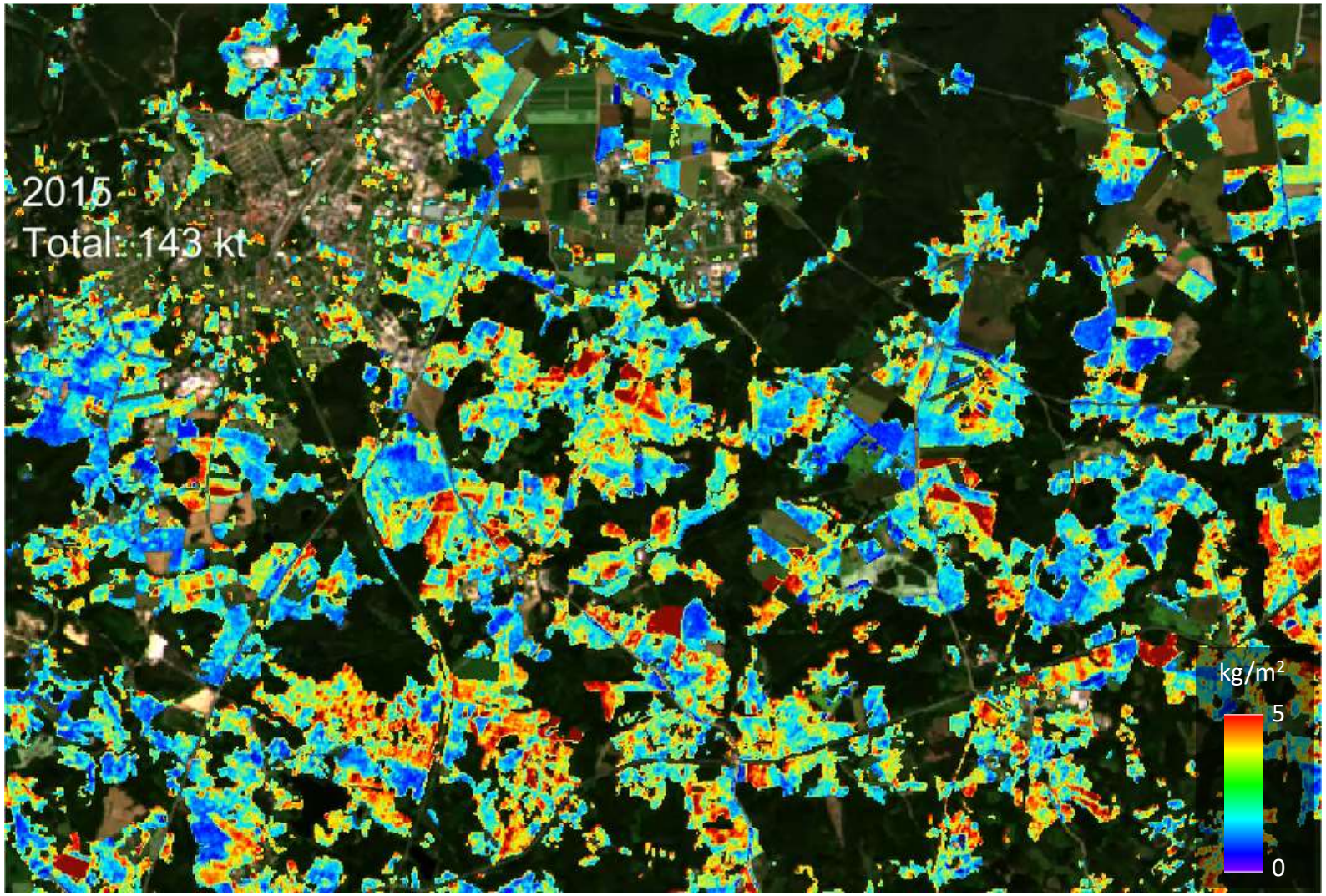
Mapping of grasslands and assessment of green grass biomass

Biomass variations within classified grasslands obtained from Sentinel-2 data



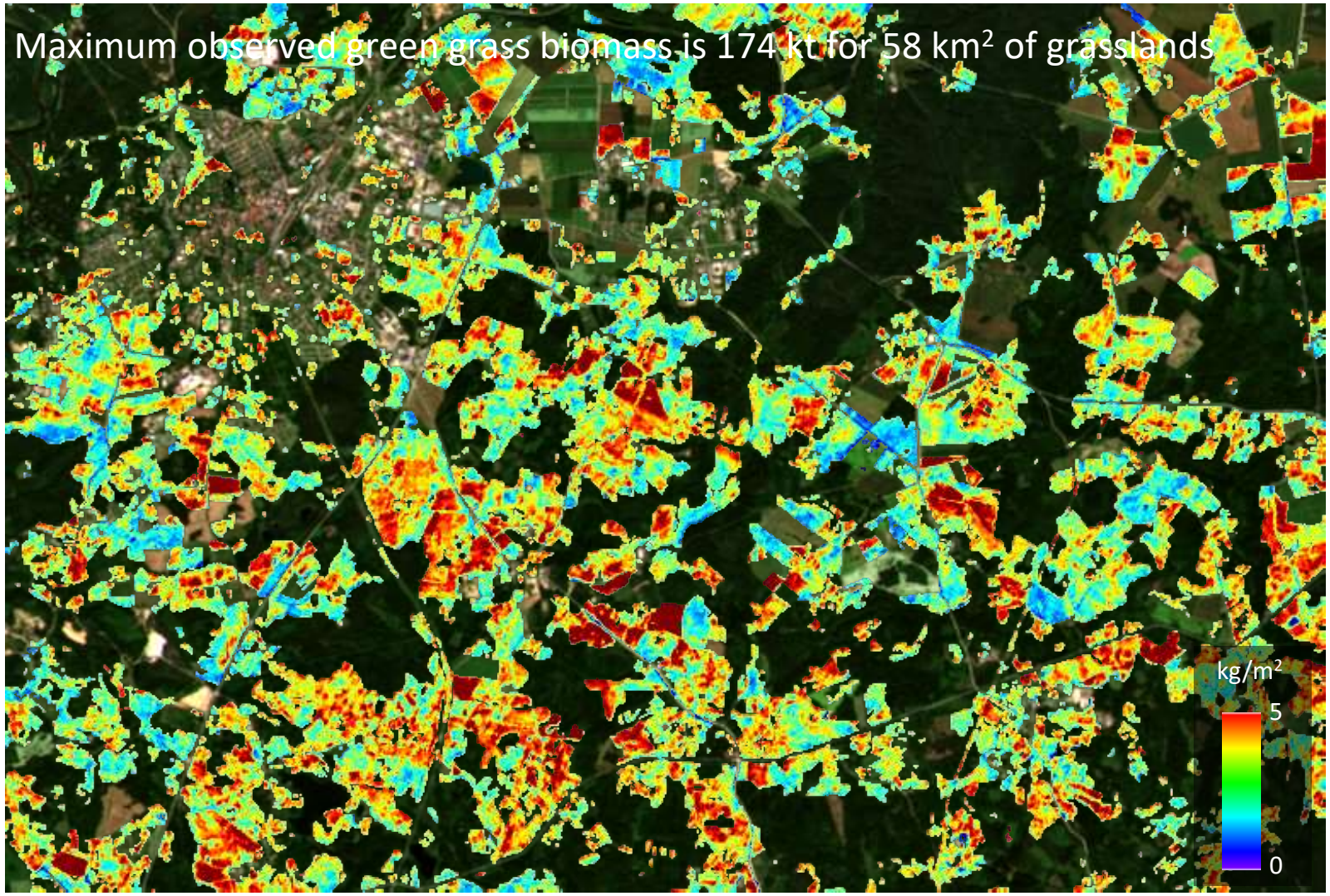
Mapping of grasslands and assessment of green grass biomass

Biomass variations within classified grasslands obtained from Sentinel-2 data

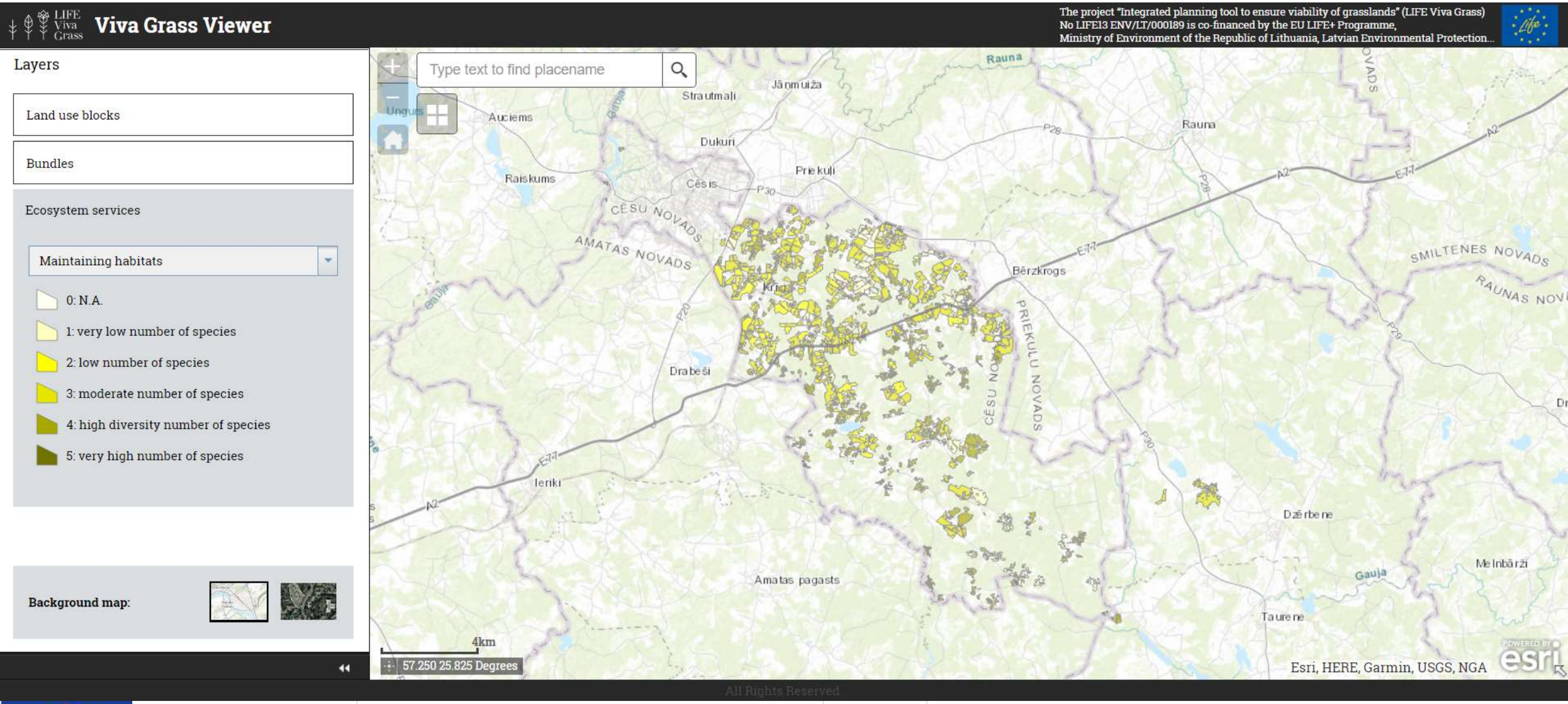


Mapping of grasslands and assessment of green grass biomass

Biomass variations within classified grasslands obtained from Sentinel-2 data



Integrated planning tool



Conclusions

- Grasslands and shrubs / trees could be automatically mapped using airborne remote sensing (spectral and LiDAR) techniques with high accuracy (>90%) and high spatial resolution (up to 1 m/pix). High accuracy (~90%) also could be achieved using Sentinel-2 satellite spectral data but spatial resolution is limited to 10…20 m/pix. High temporal dimension is the main benefit of satellite data allowing to include non-ploughing criteria for classification of grasslands. It was observed that ploughed grasslands are misclassified as agricultural land, thus showing potential for detection of possible violations in the CAP.

- The spread of Sosnowsky's hogweed (*Heracleum sosnowskyi*) could be automatically mapped using airborne remote sensing techniques with high accuracy (>90%) and high spatial resolution (up to 1 m/pix). Sentinel-2 data is useful for monitoring of management practices of Sosnowsky's hogweed but is limited to large stands due to 20 m/pix spatial resolution.

- Assessment of green grass biomass was based stepwise linear regression. The optimal five BRI linear model resulted in RMSE = 449 g/m^2 and R^2 = 0,63.

- Remote sensing has shown to be a useful and effective approach for automatic mapping and monitoring of grasslands.

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