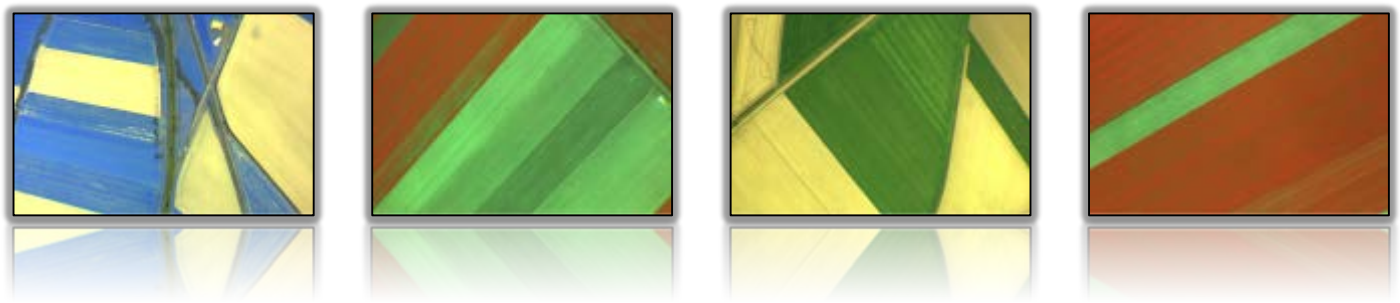
instituteofaviation
warsaw, since 1926

Life+ HESOFF

LIFE11 ENV/PL/000459

Remote Sensing Division and operational use of multispectral images

M.Sc. Eng. Hubert Skoneczny



27 September 2018

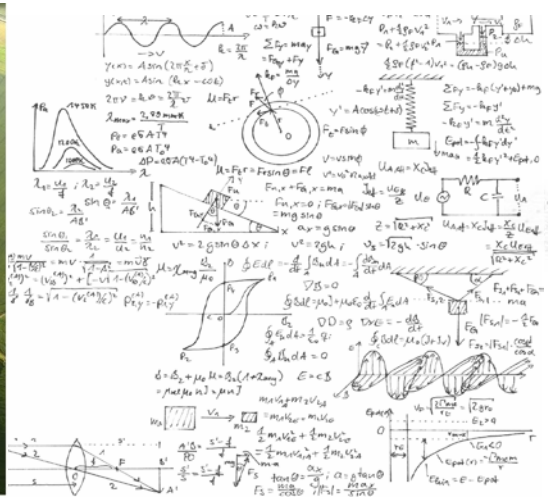
Institute of Aviation

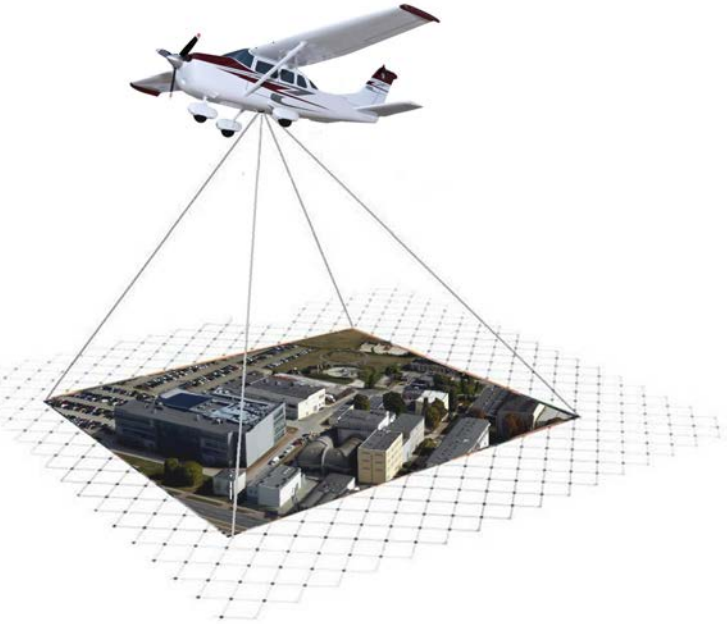
- Located in Warsaw, near Warsaw Chopin Airport
- Over 1300 employees
- Over 90 years of R&D
- Dedicated Center of Space Technologies CST
- Various space and environmental projects

Remote Sensing Division

Implementation of remote sensing missions on air and satellite observations:

- mission preparation and planning,
- aerial images acquisition,
- satellite scenes and data acquisition,
- preliminary evaluation and analysis of data.





Processing and validation of observation data collected during the mission:

- multispectral analyzes,
- statistical analysis of observational data,
- conducting numerical simulations planned.

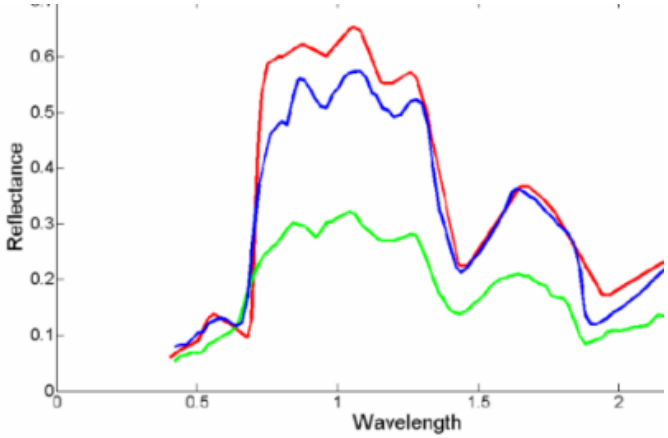
Remote Sensing Division

Nicolet iS50 FTIR & Evolution 220

FLIR IR 6020

Panalytical FieldSpec4 Hi-Res

PARROT SEQUOIA+



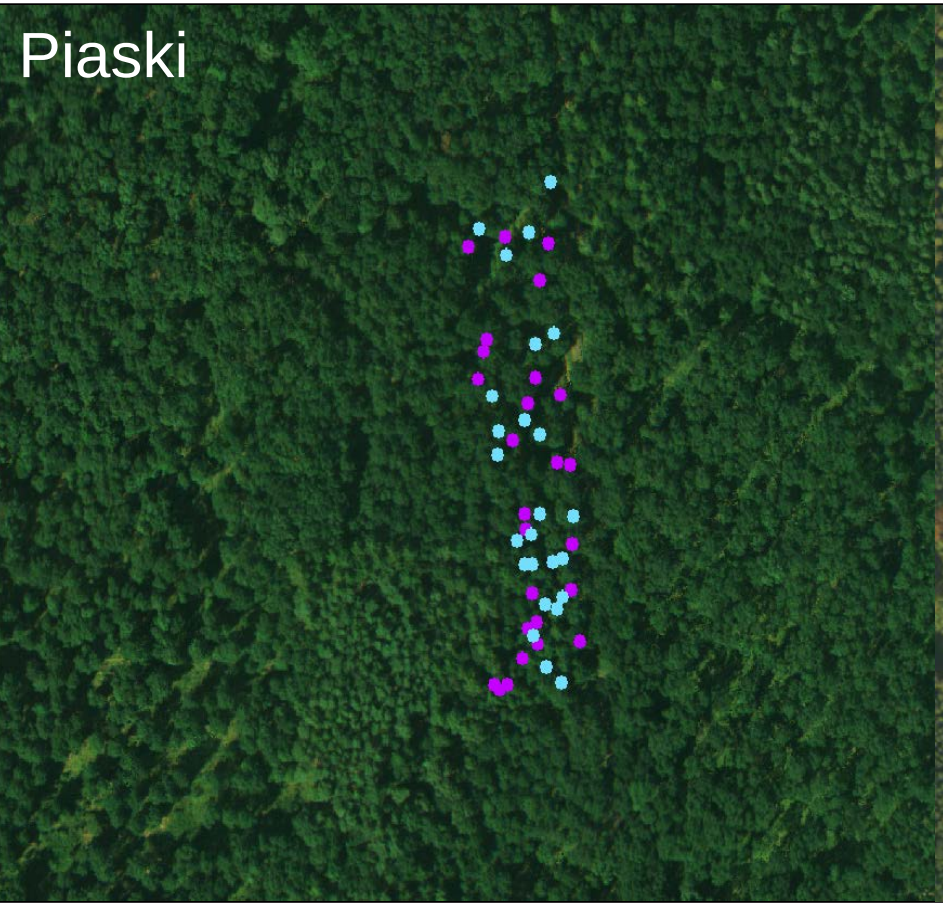
HESOFF
LIFE11 ENV/PL/000459

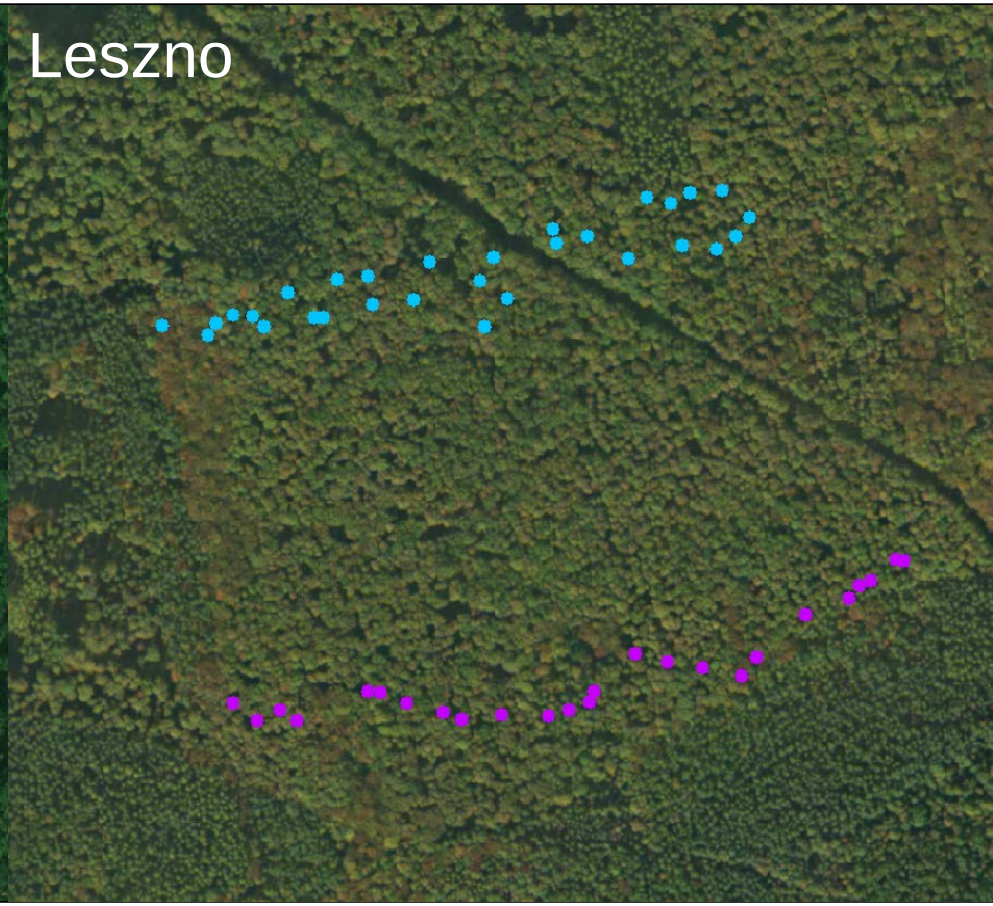
Evaluation of the health state of forests and an effect of phosphite treatments with the use of photovoltaic UAV

1. Evaluation of the influence of phosphites as elicitors of tree resistance to pathogens of the genus Phytophthora

2. Implementation of new methods of forest health state assessment and the effectiveness of cultivation through aerial imaging of the Unmanned Aerial Vehicle (UAV)

Life + HESOFF – research areas and methods of phospites application





Life + HESOFF – research areas and methods of phospites application

Krotoszyn

- 29 Control Trees
- 27 Treatment Trees

Leszno

- 25 Control Trees
- 30 Treatment Trees

Piaski

- 27 Control Trees
- 25 Treatment Trees

Life + HESOFF environmental problem

The phenomenon of FOREST DIEBACK has been known in Europe since the beginning of the 19th century, and the first signs of dying oaks in Poland come from the 1950s from Krotoszyn. The observation shows that the increasing deterioration in the stands health is taking an alarming rate.

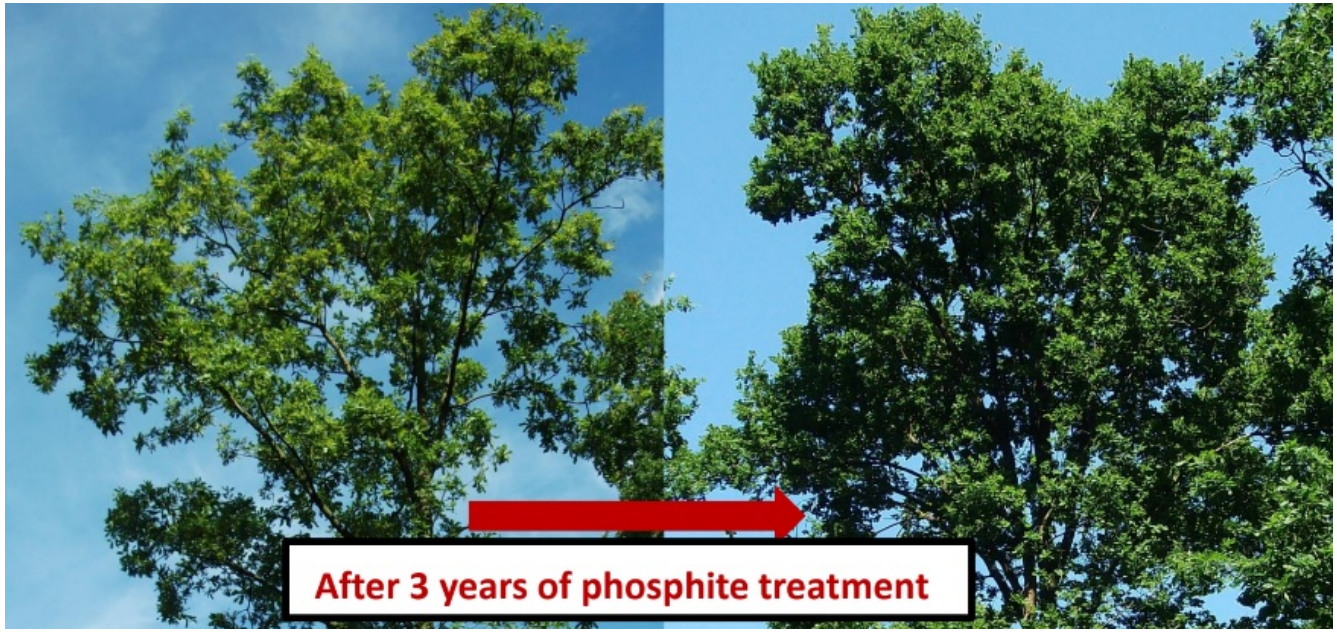
Signs of forest dieback:

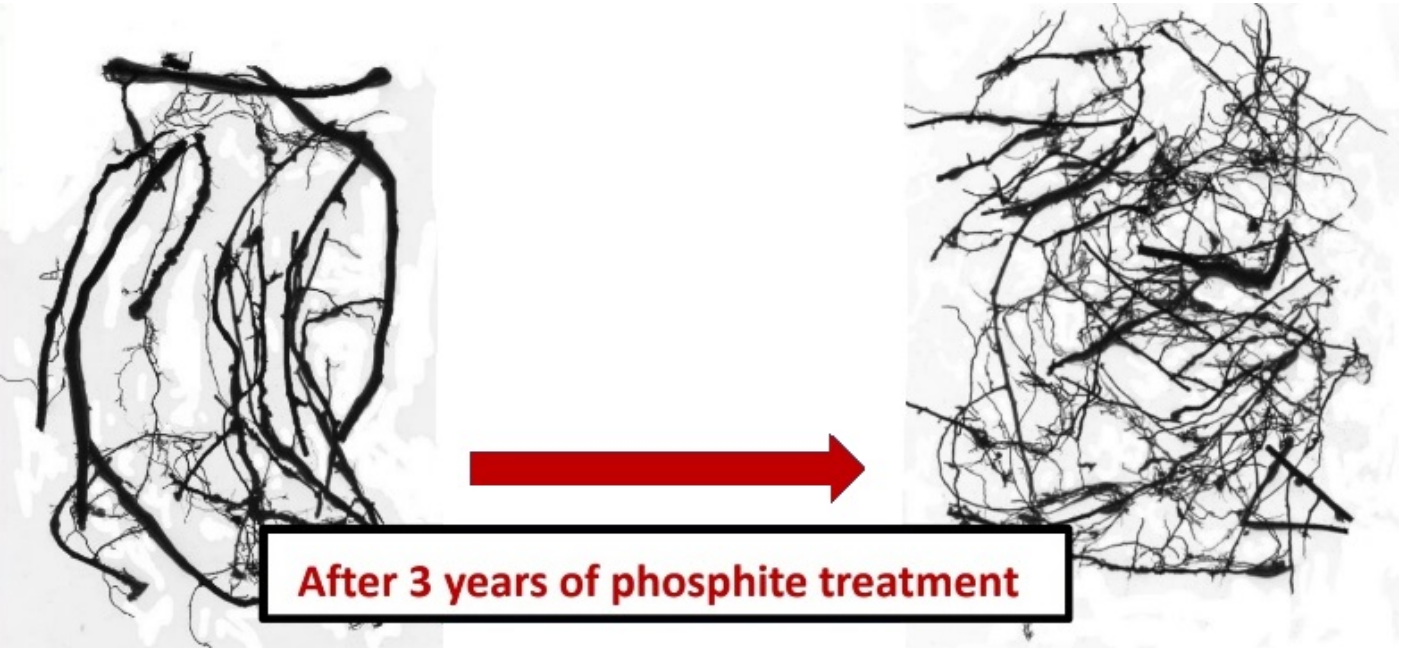
- yellowing and hypoplasia of leaves,
- thinning of crowns,
- branching off,
- juicing from beneath the bark layers of trunks,
- visible discolorations in the bent wood.

Currently, it is known that fungus-like organisms of the genus Phytophthora play a significant role in the course of dieback of oaks. Oaks die as a result of damage to even 90% of fine roots by fungal pathogens living in the soil belonging to the genus Phytophthora and associated with the aquatic environment.

Life + HESOFF results

Reduction of the trees crowns defoliation





Improvement of fine roots structure

Life + HESOFF results

RSI – Remote Sensing Indicators

Image acquisition and mosaicking → RSI acquisition → Statistical analysis → Classification

DoM	Date
1	11.06.2014
24	04.07.2014
100	18.09.2014
106	24.09.2014
141	29.10.2014
366	11.06.2015
407	22.07.2015
463	16.09.2015
702	12.05.2016
1113	27.06.2017

Tree_id	Mean_Value (RSI)
1	0,82742750310
3	0,81117575621
4	0,82339744438
9	0,83715328203
12	0,83344690065
13	0,80946880579
14	0,79209461250
16	0,82138830038
23	0,80167678560
24	0,81333189370
27	0,85479186867
31	0,83894174160
…	…

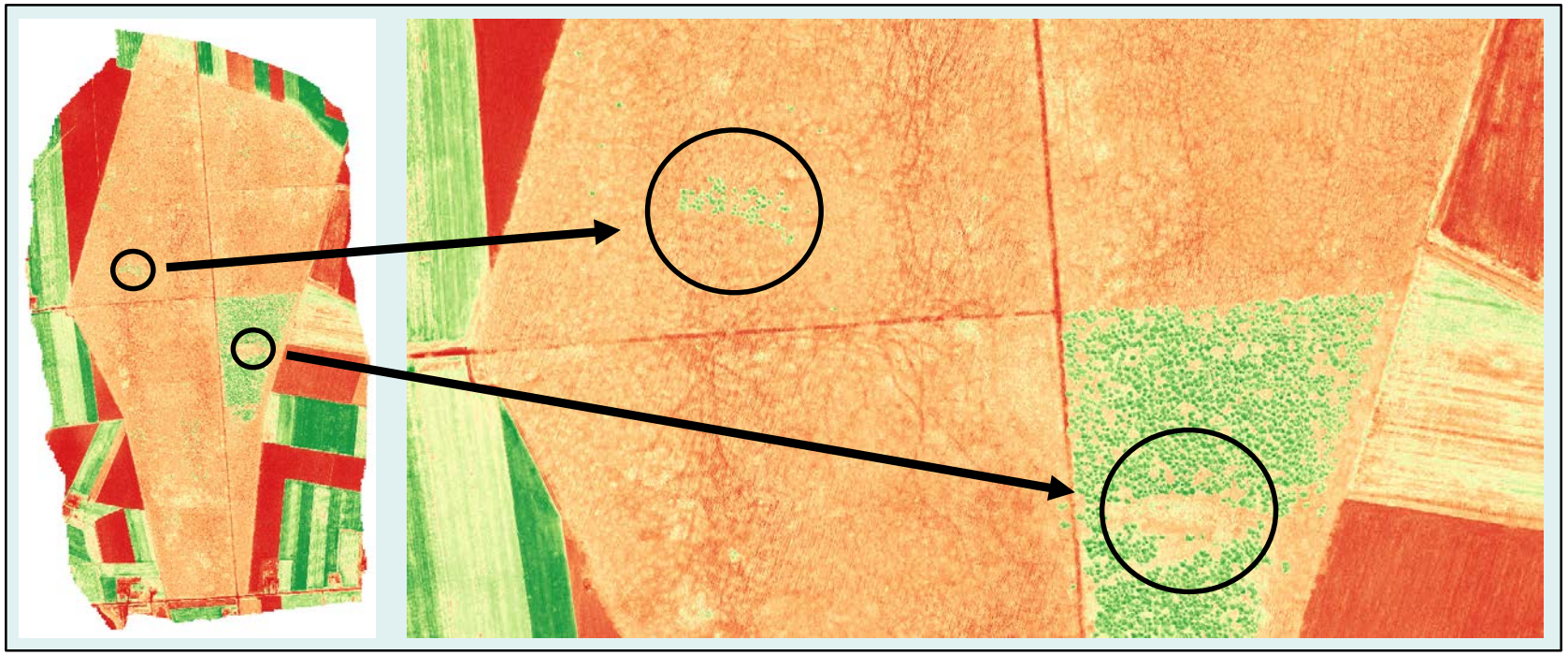
Usage of products created from multispectral images (on an example of application in forestry)

Health state evaluation

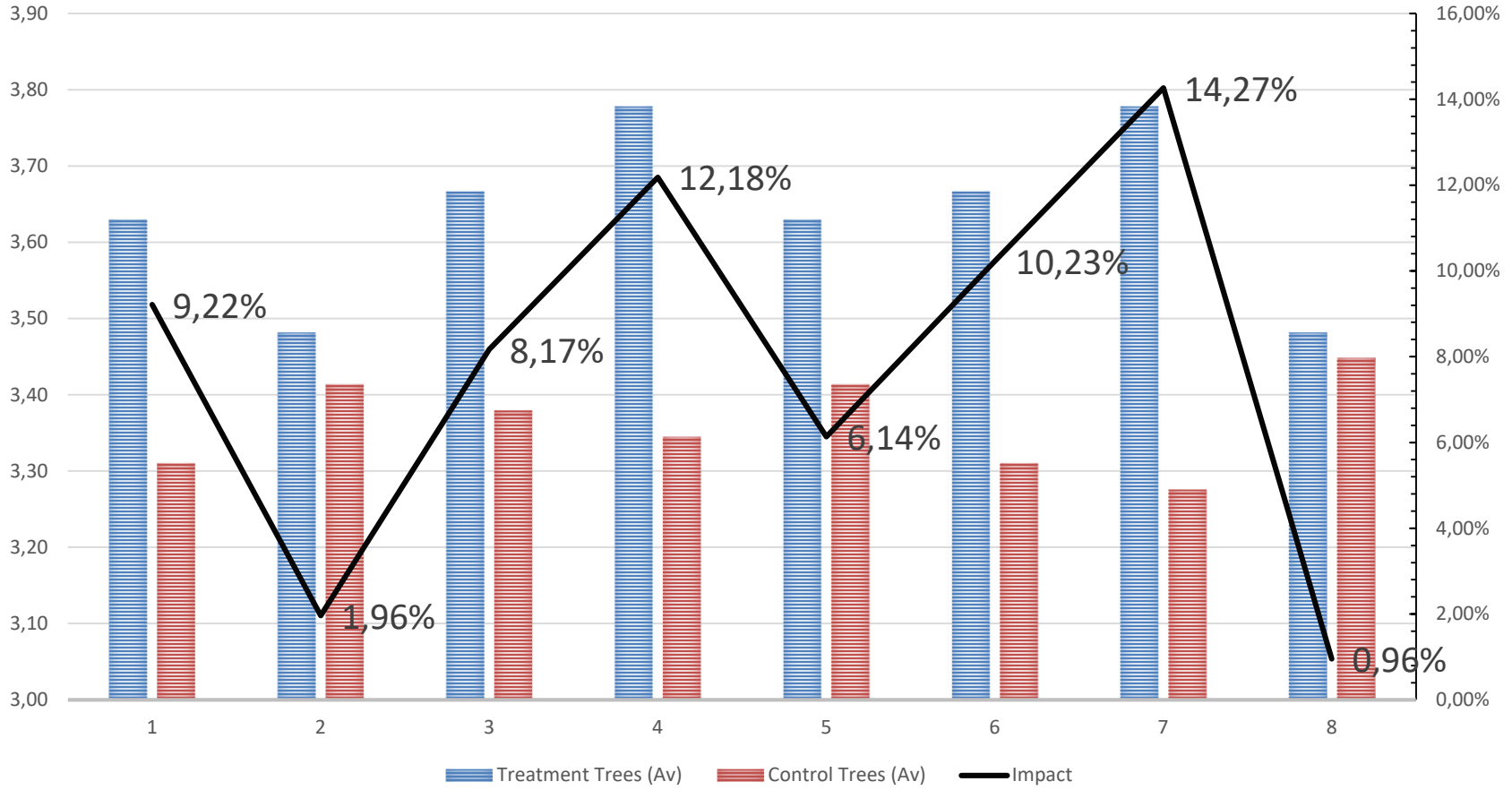
NDVI - **N**ormalized **D**ifference **V**egetation **I**ndex (graphical indicator describing condition of the vegettion)

$$NDVI = \frac{(NIR - VIS)}{(NIR + VIS)}$$

NIR - reflection in the near-infrared band
VIS - reflection in the red band



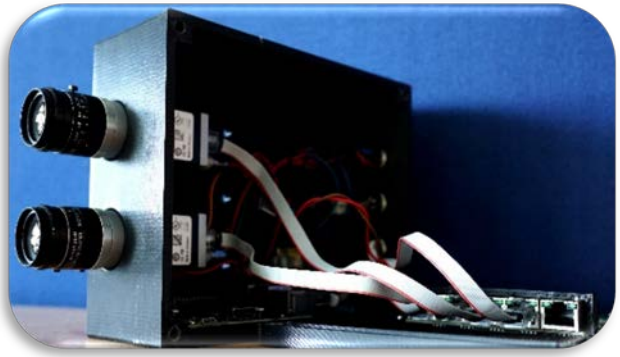
Life + HESOFF results



KROTOSZYN:

Treatment Trees (Av)	3,63	3,48	3,67	3,78	3,63	3,67	3,78	3,48
Control Trees (Av)	3,31	3,41	3,38	3,34	3,41	3,31	3,28	3,45
Impact	9,22%	1,96%	8,17%	12,18%	6,14%	10,23%	14,27%	0,96%
DoM	**1**	**24**	**100**	**106**	**366**	**407**	**463**	**1113**

QUERCUS.2



Parameter	Value
Sensor sensitivity	460 – 950 nm
Spectral channels	2
No. of frames	5 / s
Max. amount of images	61 000
Lenses diameter	20 mm
Ground pixel for h= 200 m	6-7cm
Total weight	820 g
Working time	1,5 h

QUERCUS.6

Parameter	Value
Sensor sensitivity	460 – 1000 nm
Spectral channels	6
No. of frames	5 / s
Max. amount of images	61 000
Lenses diameter	20 mm
Ground pixel for h= 200 m	6-7 cm
Total weight	4000 g
Working time	1,5 h

QUERCUS.2 and **QUERCUS.6** were created for the purpose of **LIFE HESOFF** project to acquire images of research areas. The acquired material was used during the implementation of one of the main tasks of the project - evaluating the health state of oak stands in the context of the assessment of phosphites as elicitors of tree resistance to pathogens of the genus Phytophthora.

Acquiring pictures - carrying systems of a multispectral platform

Unmanned Aerial Vehicle (UAV)

Unmanned Aerial System is a set of many integrated devices that closely cooperate with each other and enables the implementation of (unmanned) remotely controlled flight. Its functionality and application are determined by mounted on-board optical sensors.

Selected parameters::

- Wingspan: 3,85 m
- Max. take-off weight: 25 kg
- Flight altitude: 3500 m AMSL
- Cruising speed: 21-25 m/s
- Range: 30 km
- Flight time: 45 min

Plane

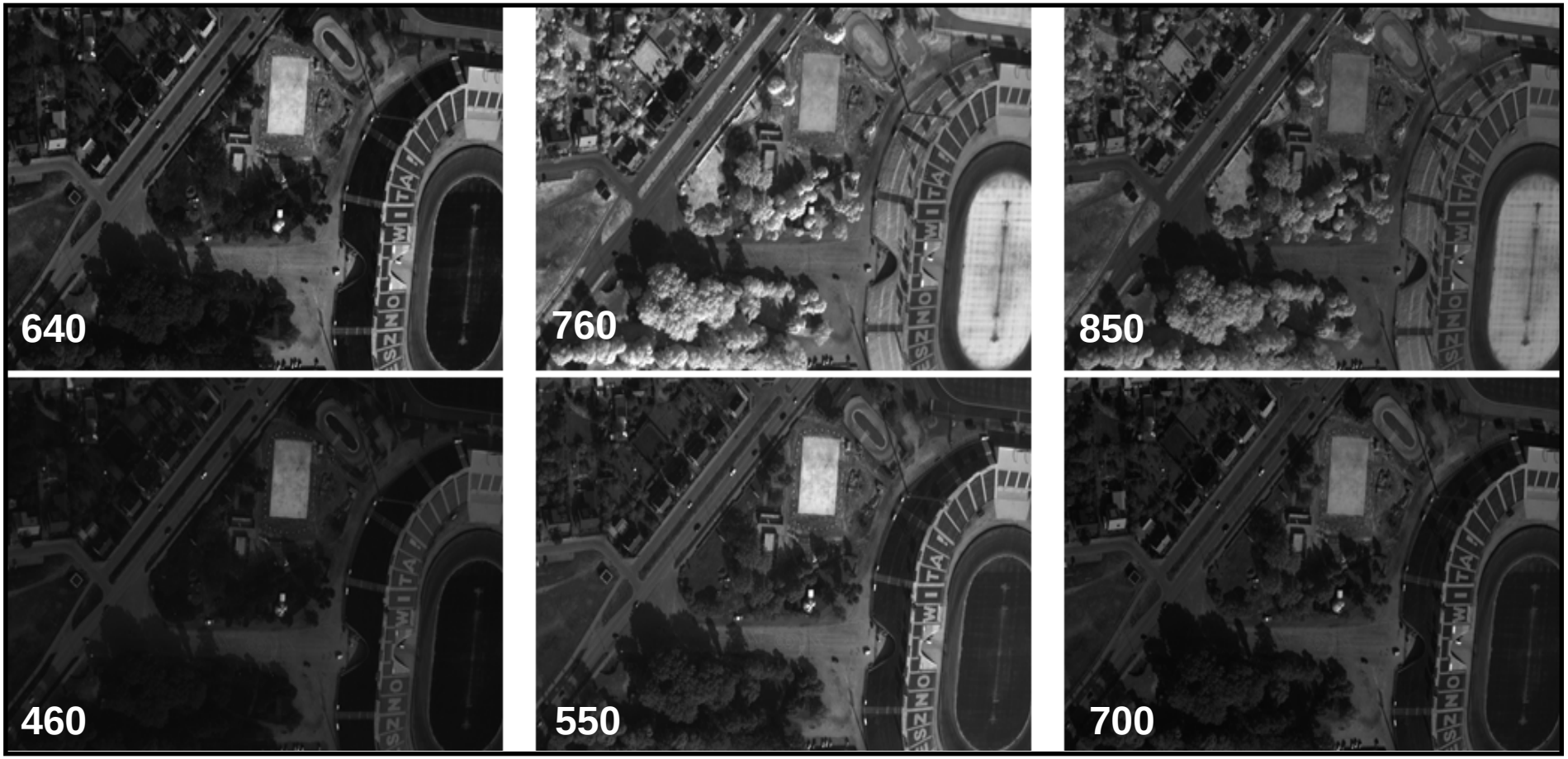
Planes have an advantage over UAVs, because their maximum flight time, load capacity and cruising altitude are much higher.

The obvious disadvantage of using plane is the price of their operation and limited availability.

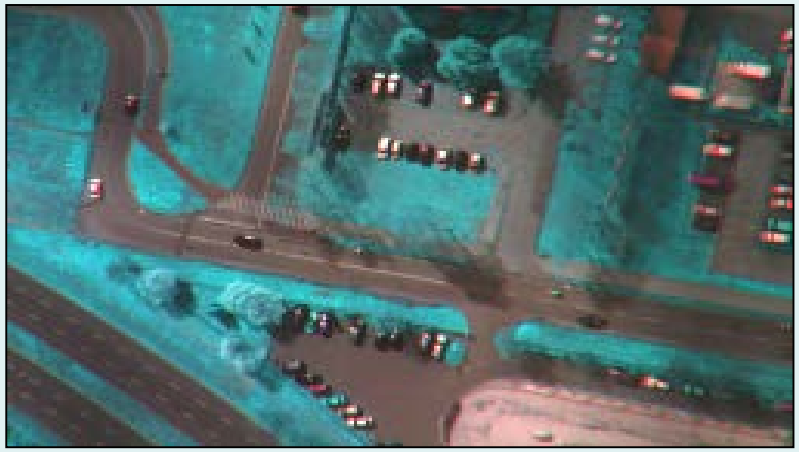
Photogrammetric plane
Partenavia (Vulcanair) P68 TC
Observer

Phoenix (1:10) – images acqusition

Raw images obtained from photogrammetric flight with use of QUERCUS.6



Multispectral images

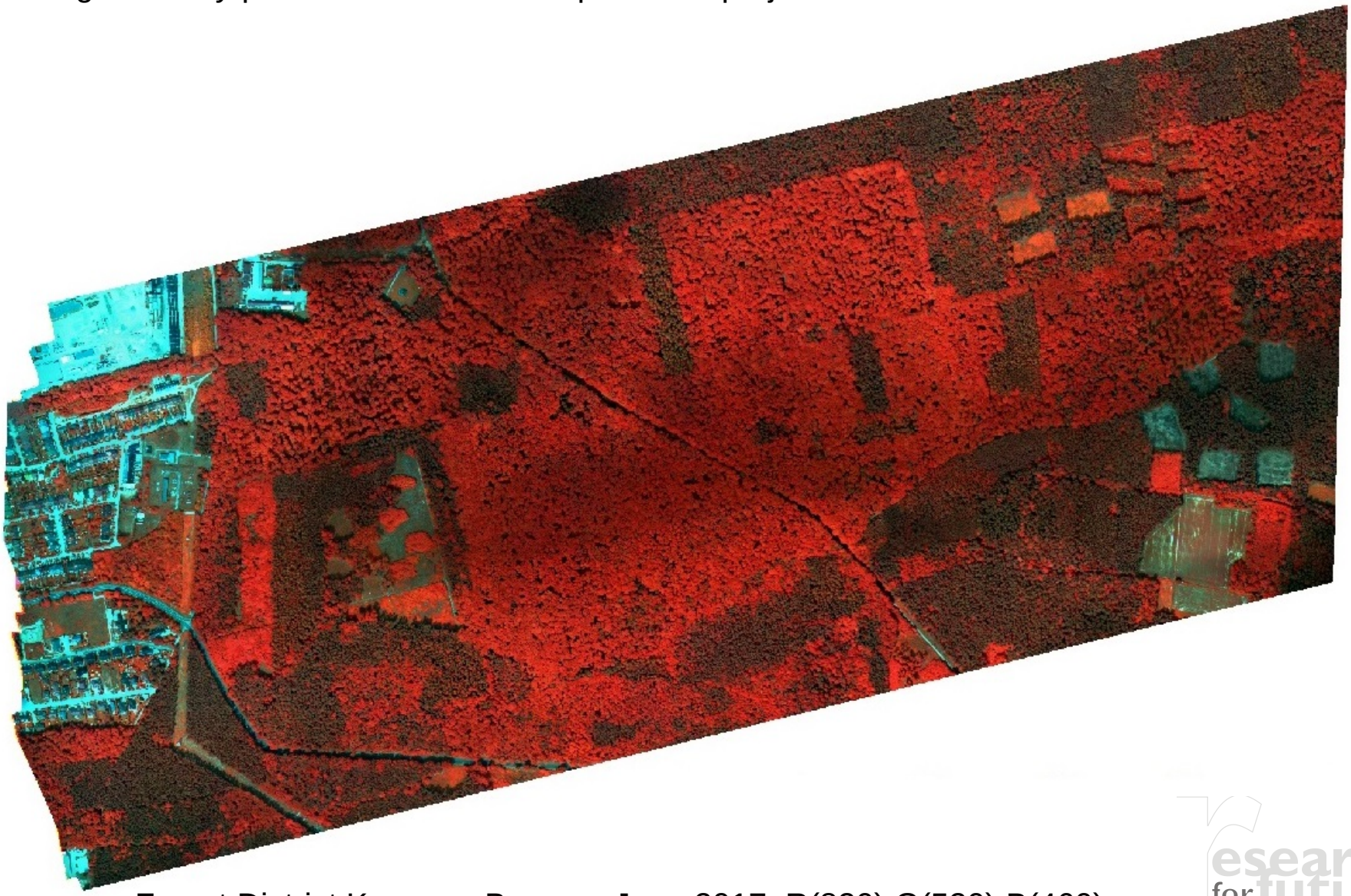


Photogrammetry products - on the example of the project HESOFF LIFE11 ENV/PL/000459

Photogrammetry products - on the example of the project HESOFF LIFE11 ENV/PL/000459

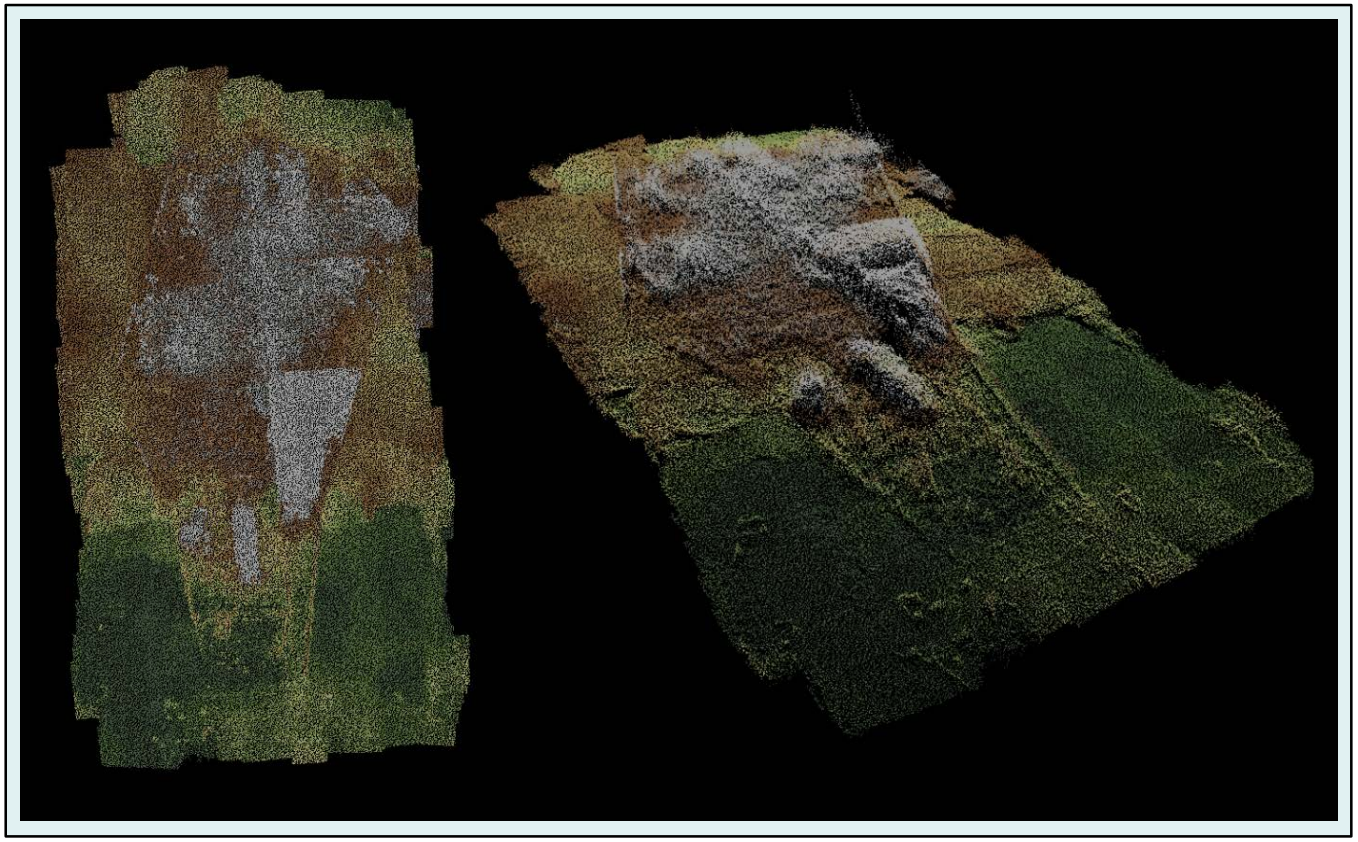
Forest District Karczma Borowa, May 2016, R(670) G(520) B(460)

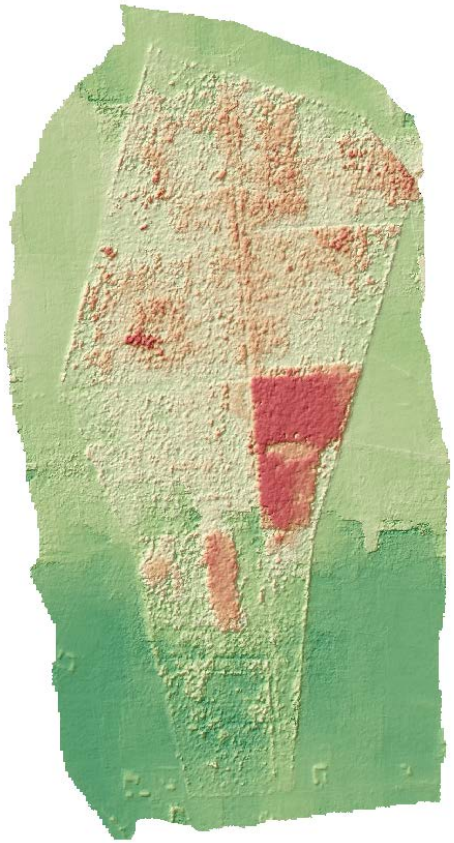
Photogrammetry products - on the example of the project HESOFF LIFE11 ENV/PL/000459



Forest District Karczma Borowa, June 2017, R(820) G(520) B(460)

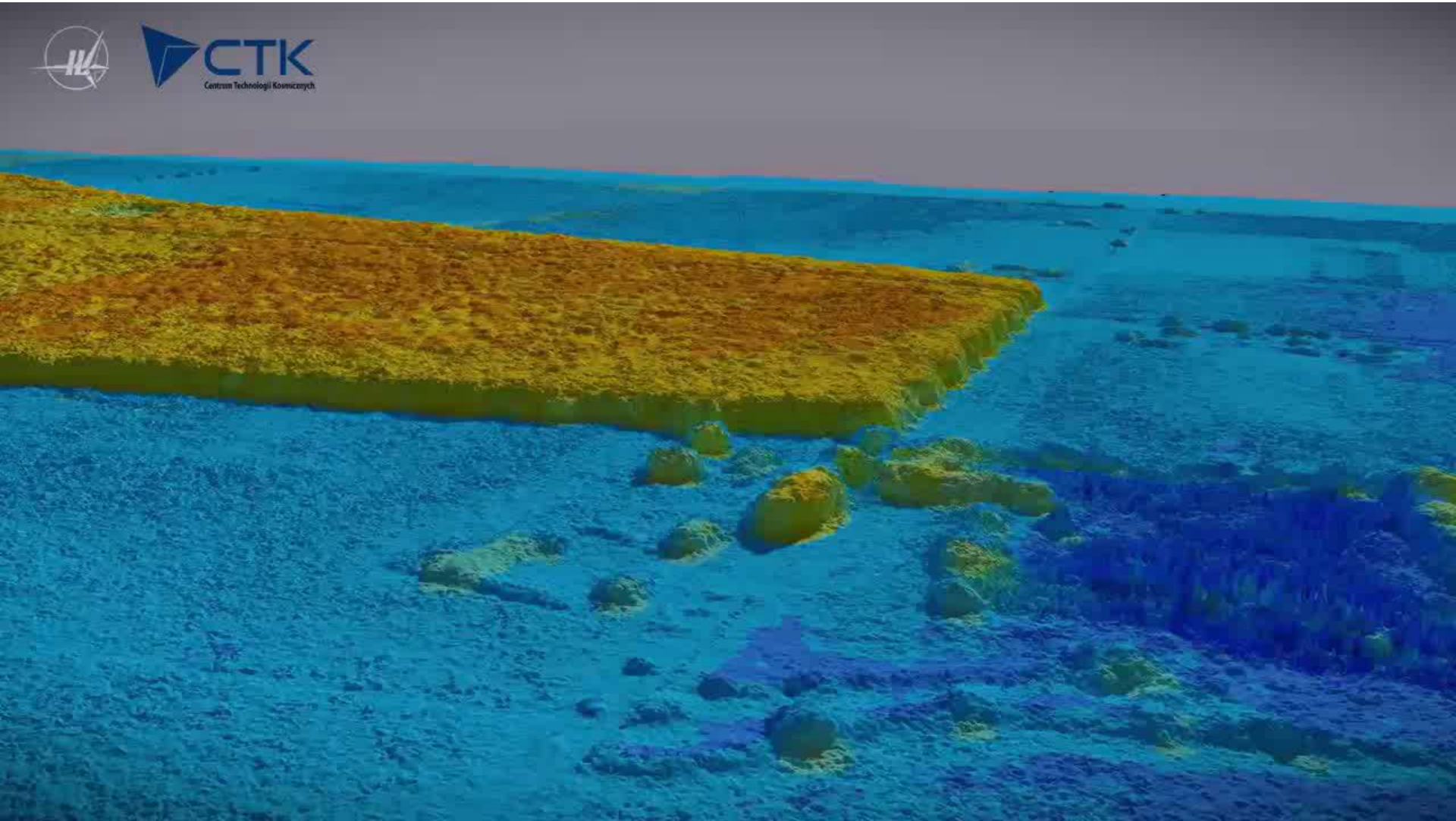
Photogrammetry products - on the example of the project HESOFF LIFE11 ENV/PL/000459





Forest district Krotoszyn – elevation models

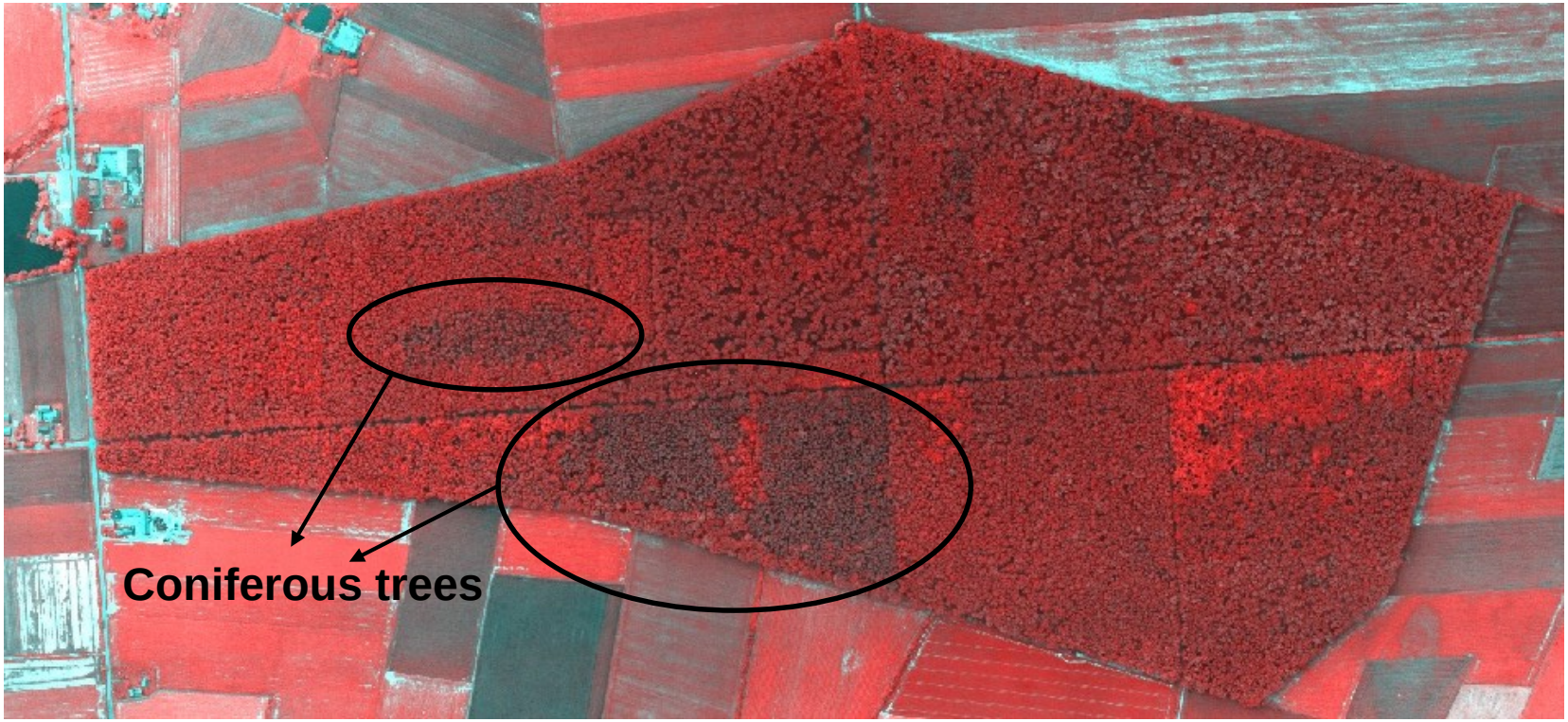
Elevation model – research area of the HESOFF project – Forest District Krotoszyn



Forestry	Evaluation of the health state of oak stands. **HESOFF Project LIFE11 ENV/PL/000459**	**Spatial planning**	Object classification aimed at land use forms detection
		Water management	Cyanobacterial blooms detection
Agriculture	Supporting the decision-making process in the context of the intensity of application of agricultural procedures	**Landscape architecture**	Creating 3D models of objects
Geology and mining industry	Surveying forms of land and their deformations related to the underground exploitation of resources	**Archeology**	Detection and inventory of historical remains

Usage of products created from multispectral images (on an example of application in forestry)

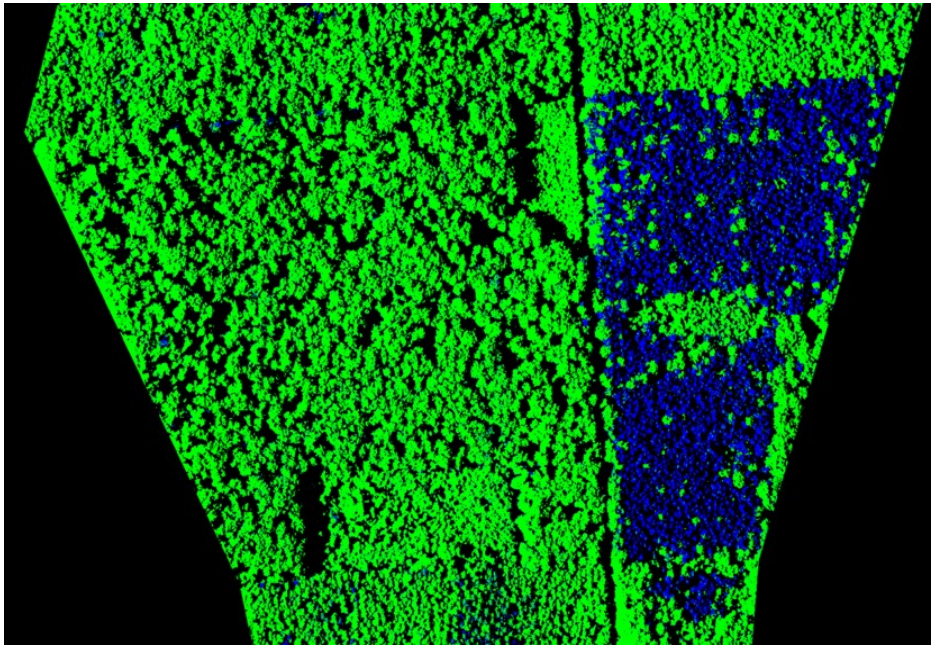
Classification



Orthophotomap of the research area in HESOFF Project - Krotoszyn Forest District. Composition created from images acquired in two spectral channels - red band (670 nm) and near infrared band (820 nm)

Usage of products created from multispectral images (on an example of application in forestry)

Classification



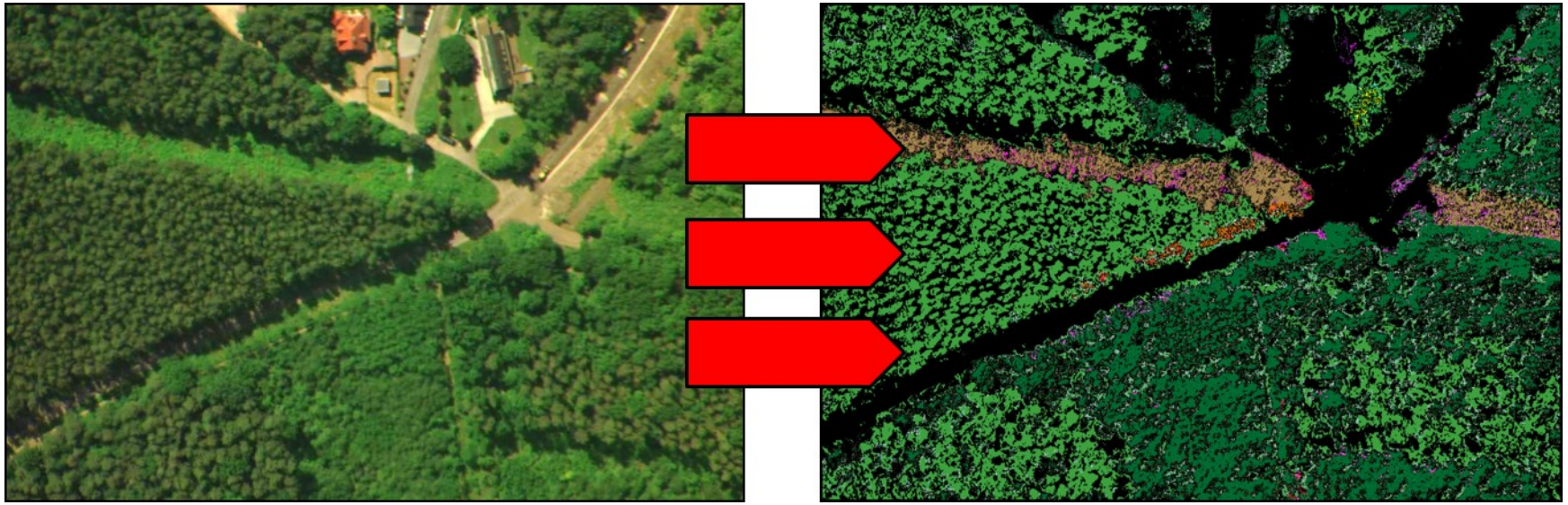
Deciduous trees

Coniferous trees

Classification of trees due to their classes, made by using algorithms and spectral characteristics – red and infrared bands reflection differences. Contrasting colors have been used to accurately represent the results.

Usage of products created from multispectral images (on an example of application in forestry)

Classification

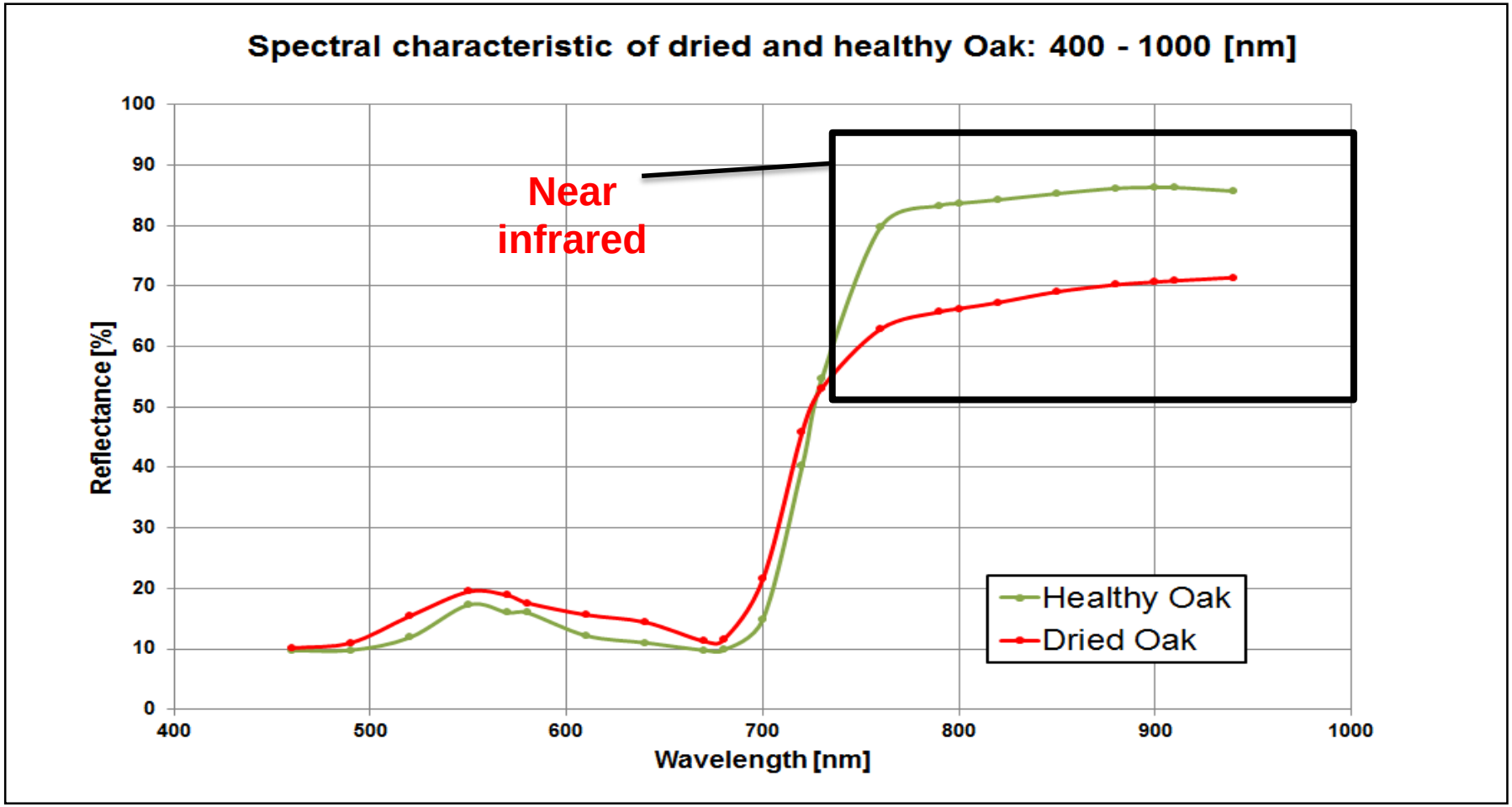


Light green – Scots pine
Dark green – English oak
Pink – Black locust

Brown – forest litter
Black – non-living matter

Usage of products created from multispectral images (on an example of application in forestry)

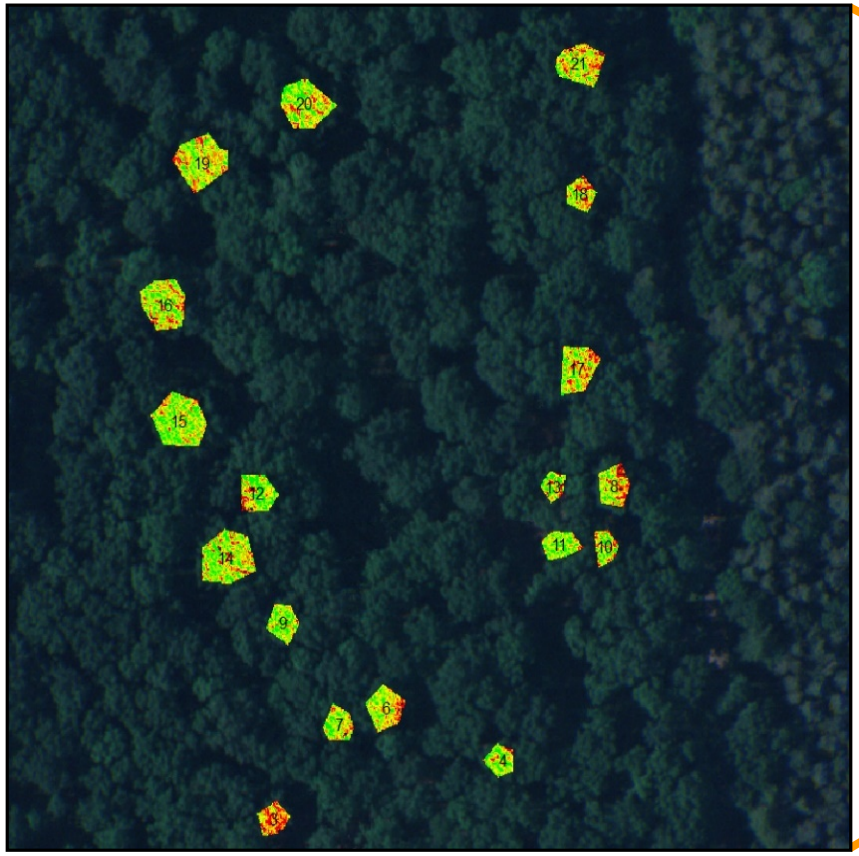
Health state evaluation



Usage of products created from multispectral images (on an example of application in forestry)

Health state evaluation

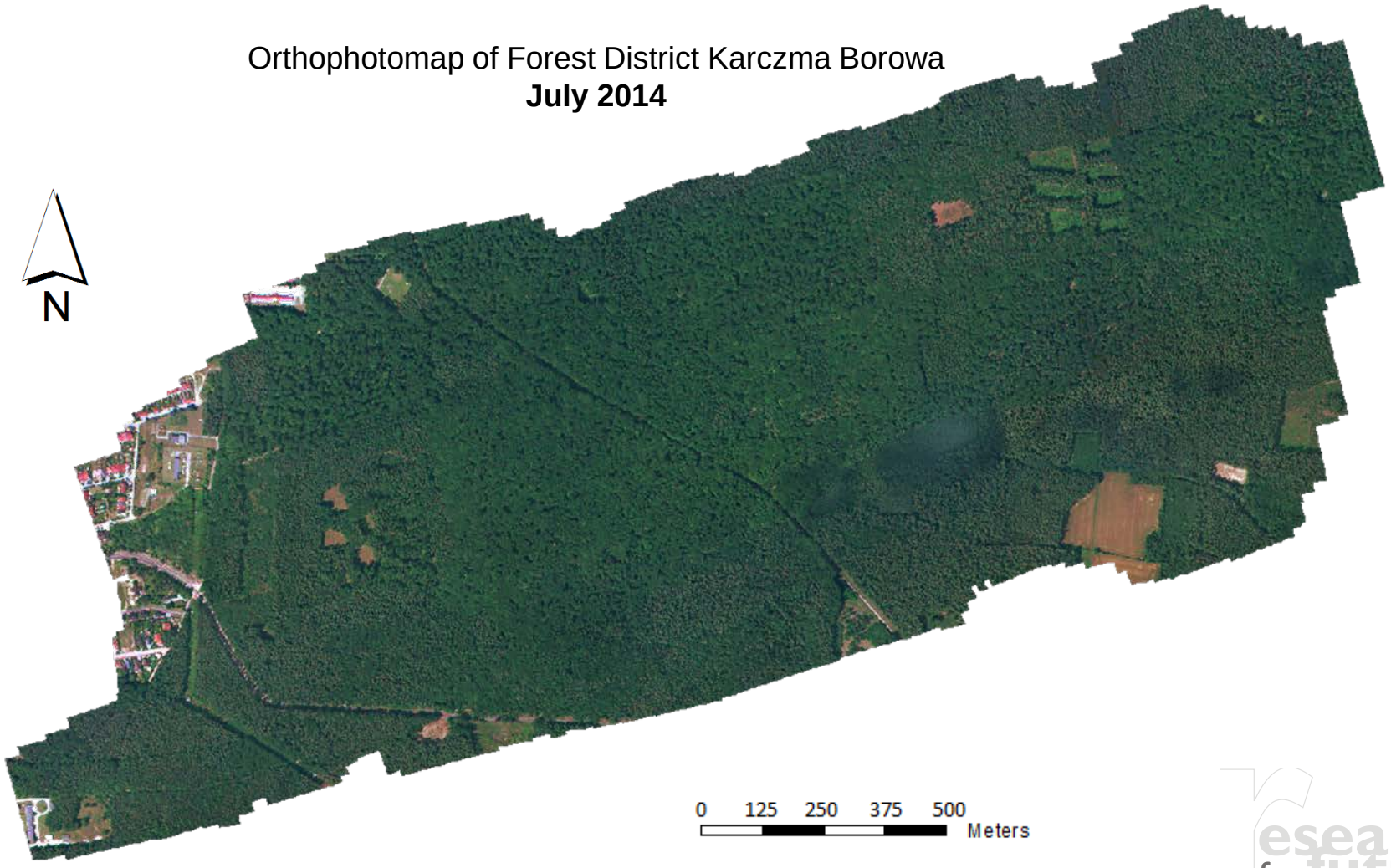
NDVI - (**N**ormalized **D**ifference **V**egetation **I**ndex)



Usage of products created from multispectral images (on an example of application in forestry)

Deforestation monitoring

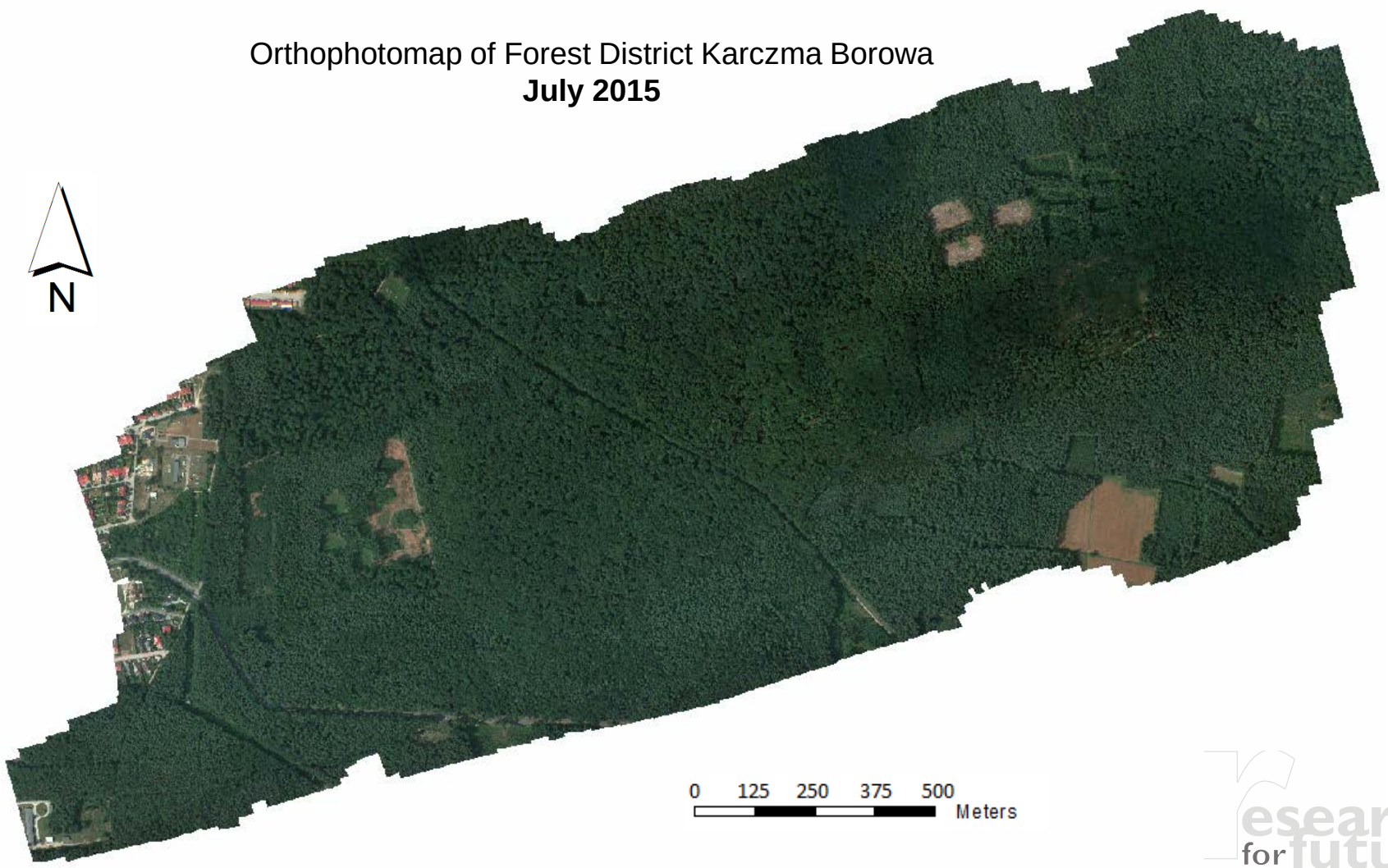
Orthophotomap of Forest District Karczma Borowa
July 2014



Usage of products created from multispectral images (on an example of application in forestry)

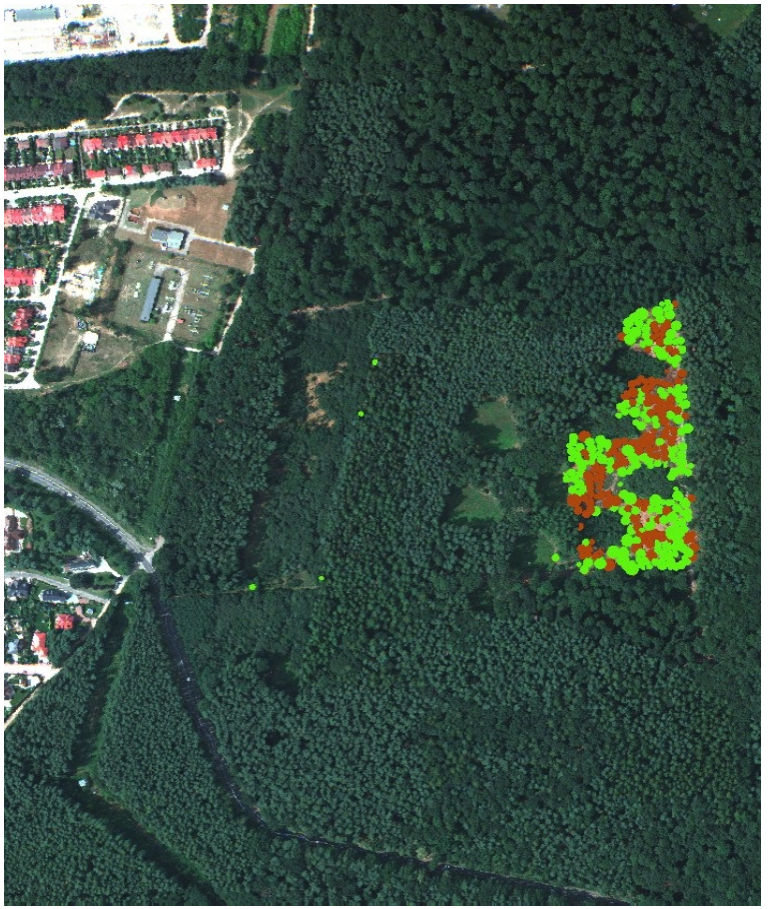
Deforestation monitoring

Orthophotomap of Forest District Karczma Borowa
July 2015



Usage of products created from multispectral images (on an example of application in forestry)

Deforestation monitoring

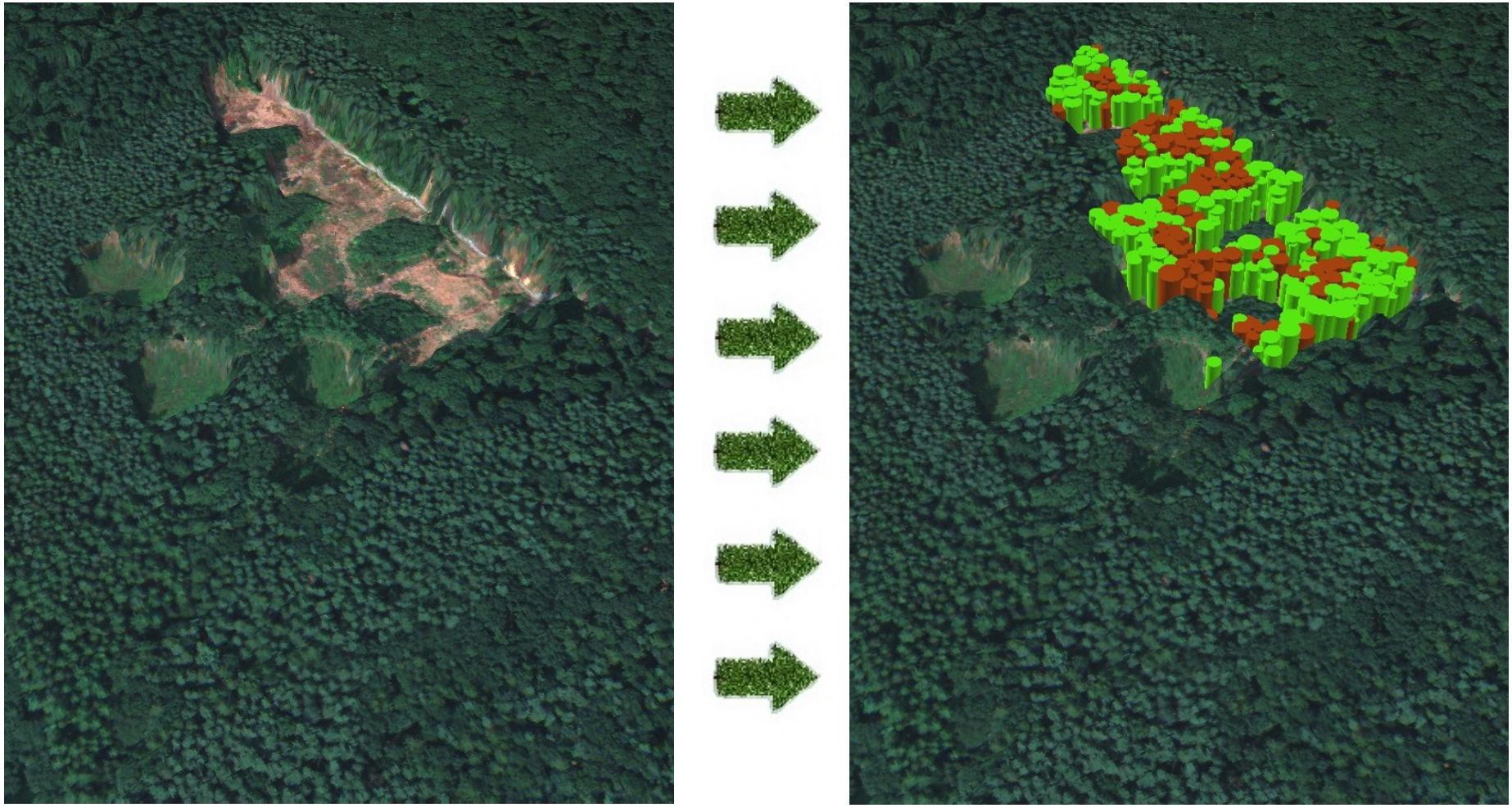


Deciduous trees

Coniferous trees

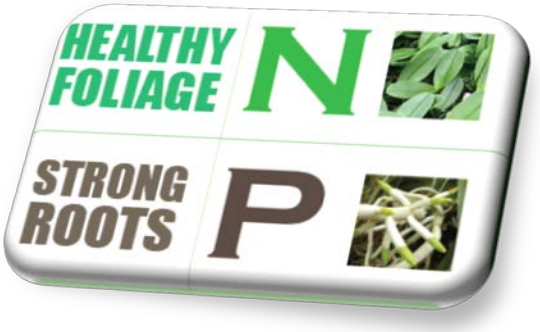
Usage of products created from multispectral images (on an example of application in forestry)

Deforestation monitoring



Estymation of chemical elements concentration in leaves – Nitrogen (**N**) and Phosphorus (**P**)

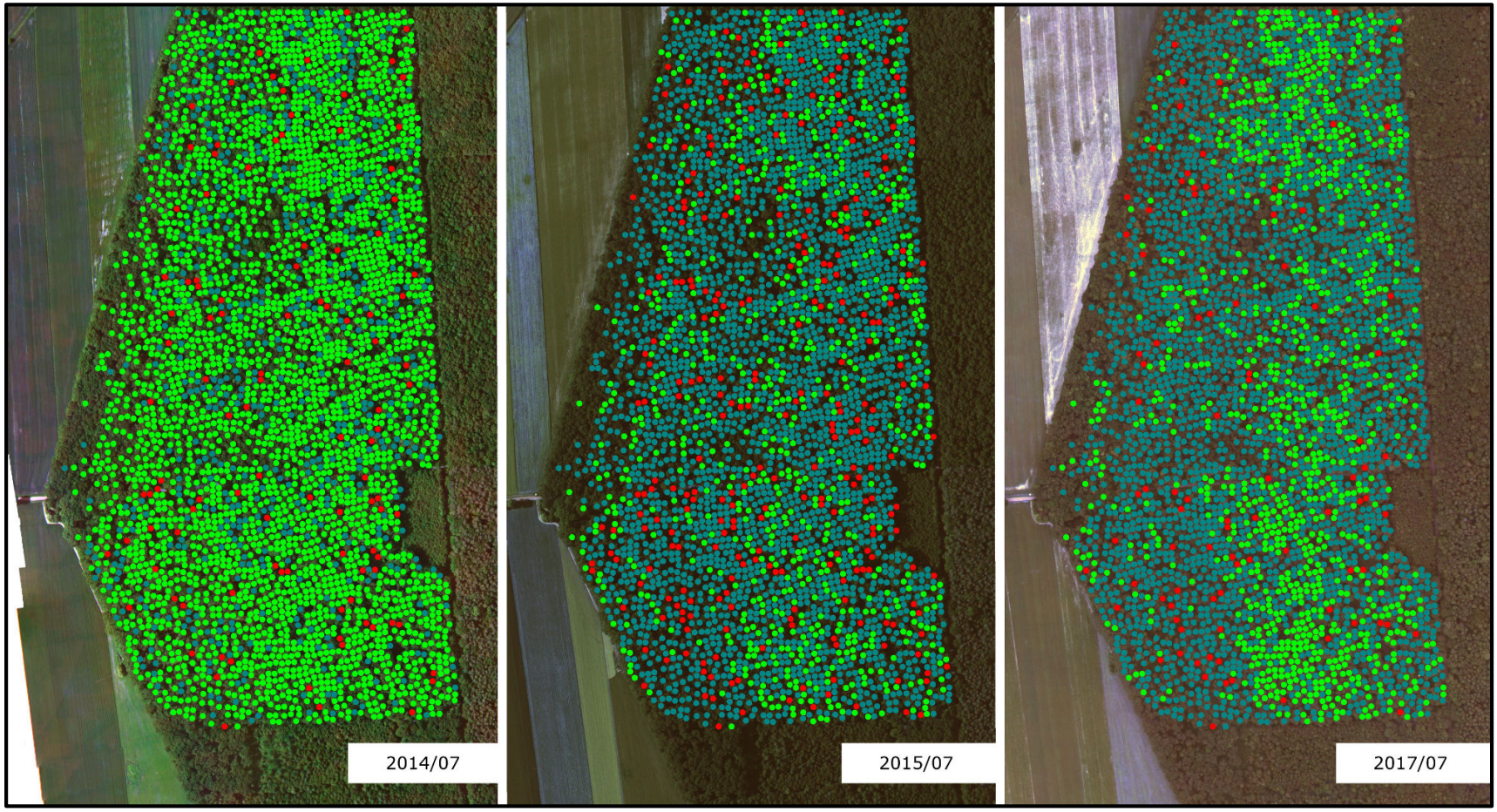
1. Laboratory measurements of concentration of **N** and **P** in leaves (for 50 trees)



2. Annual acquisition of aerial, multispectral images of forest (5 spectral ranges 440, 550, 640, 730 and 820)

3. Machine learning technics used for estimation (for over 4000 trees)

Estymation of chemical elements concentration in leaves – Nitrogen (**N**) and Phosphorus (**P**)

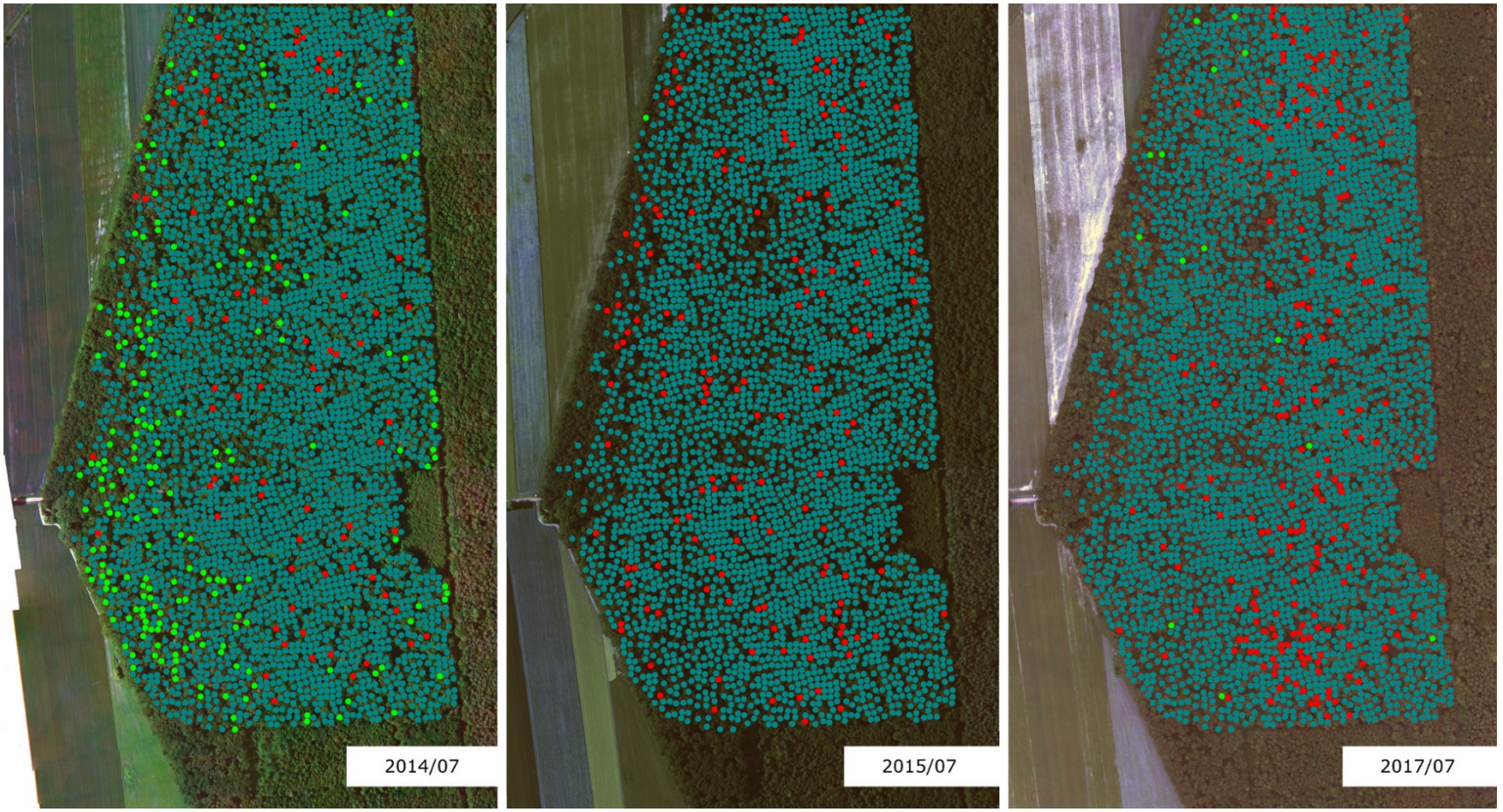


Classification of trees due to the nitrogen (N) concentration in leaves before drought (2014), during drought (2015) and after drought (2017).

N concentration:

- <15g / kg
- < 25g / kg
- > 25g / kg

Estymation of chemical elements concentration in leaves – Nitrogen (**N**) and Phosphorus (**P**)

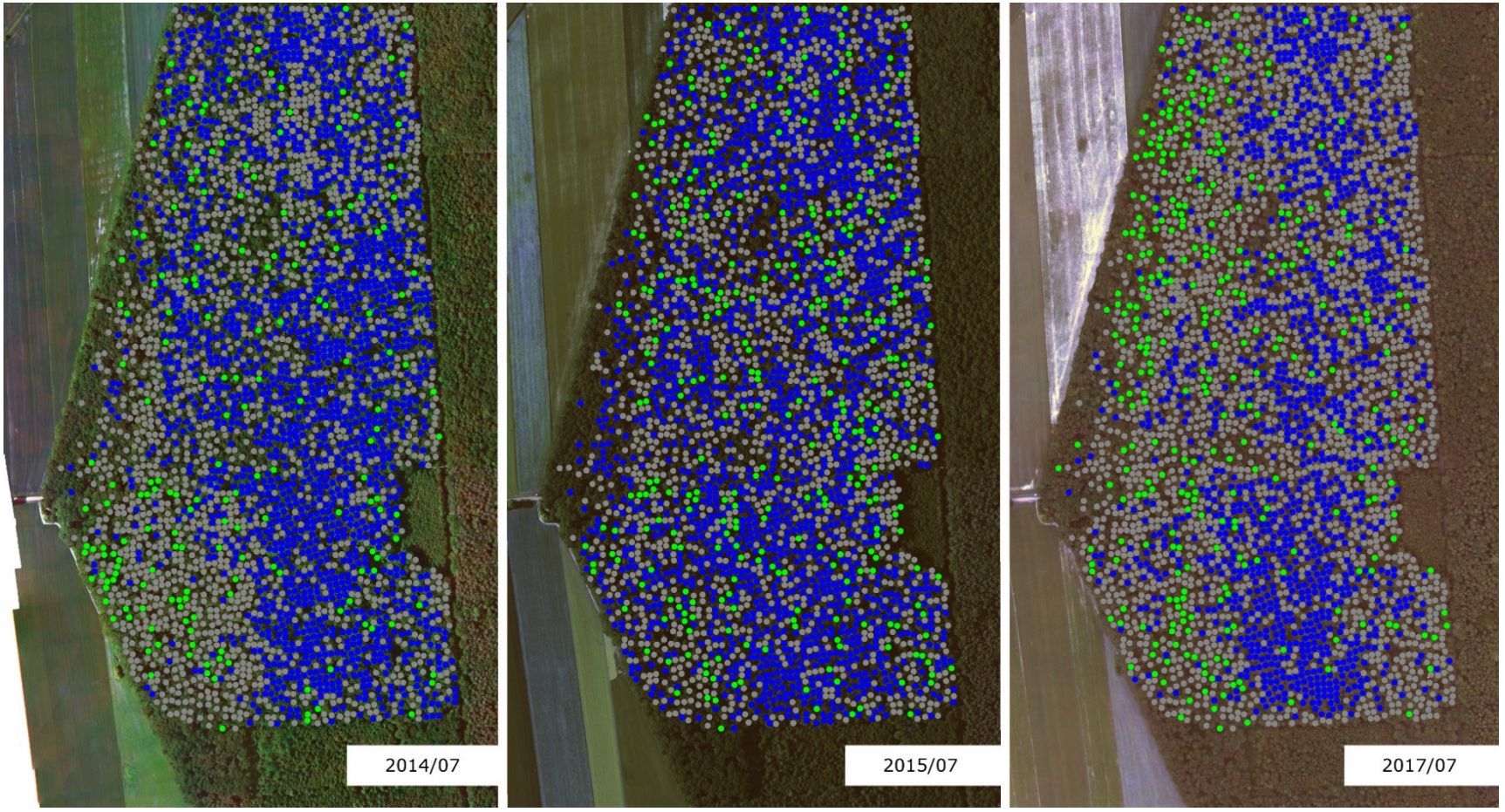


Classification of trees due to the phosphorus (P) concentration in leaves before drought (2014), during drought (2015) and after drought (2017).

P concentration:

- <1.0 g / kg
- < 3.0 g / kg
- > 3.0 g / kg

Estymation of chemical elements concentration in leaves – Nitrogen (**N**) and Phosphorus (**P**)



Classification of trees due to the N:P ratio in leaves before drought (2014), during drought (2015) and after drought (2017).

N:P ratio:

- < 8.33
- < 15.00
- > 15.00

FITOEXPORT

New project being implemented by Remote Sensing Division of the Institute of Aviation
1 January 2019

Main Inspectorate of Plant Health And Seed Inspection

- Partnership with Main Inspectorate of Plant Health And Seed Inspection;
- Usage of remote sensing technologies for surveillance of agricultural production;
- Application of a molecular test for simultaneous detection of potato viruses (Y, LR, M, S, X, A) and potato spindle tuber viroid;
- Development of a multiplex qPCR test allowing simultaneous detection of many genetic modifications in the tested seed material;
- Application of an innovative approach (ie chemometric analysis) for testing the quality of plant protection products, minimizing the risk of using falsified pesticides.

Contact:

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