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UAV methods using for monitoring of cyanobacteria blooms

Użycie metod BSP do monitoringu zakwitów sinicowych

Marcin Spiralski, Jan Kotlarz, Karol Rotchimmel, Hubert Skoneczny, Jakub Szymański, Karol Bęben, Katarzyna Kubiak Siwińska

Cracow, August 26th, 2021

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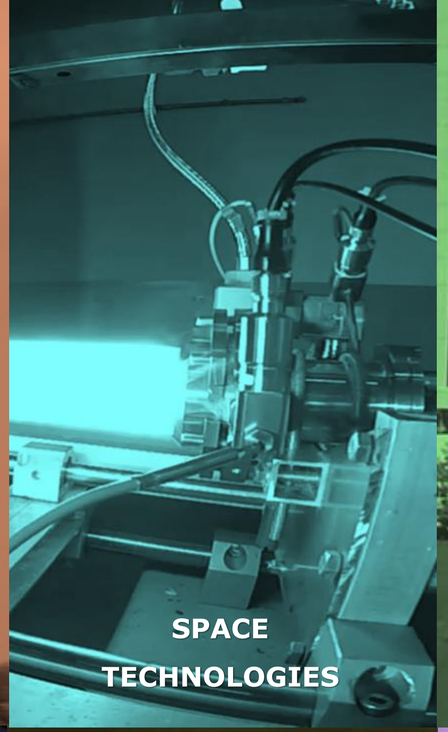
RESEARCH FOR **INDUSTRY**

AVIATION TECHNOLOGIES



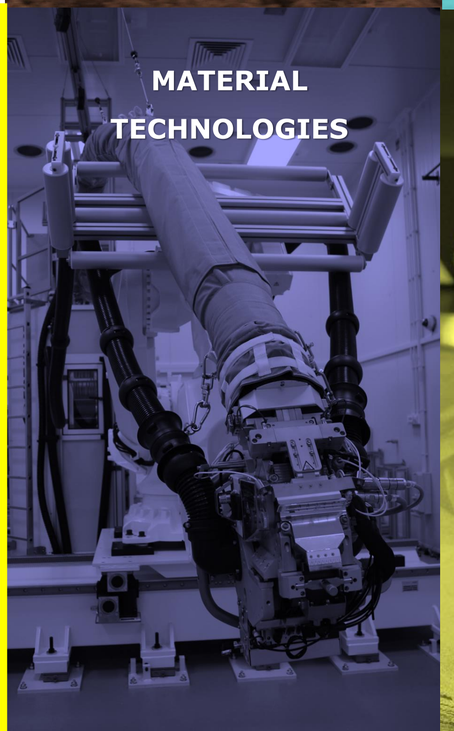
SPACE TECHNOLOGIES

UNMANNED TECHNOLOGIES

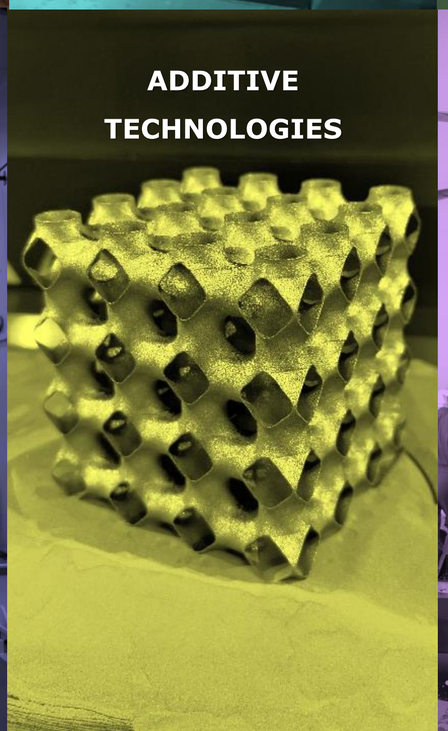
ENERGY TECHNOLOGIES

OIL AND GAS TECHNOLOGIES

REMOTE SENSING TECHNOLOGIES



MATERIAL TECHNOLOGIES



ADDITIVE TECHNOLOGIES

MILITARY TECHNOLOGIES

Algae Service for Life

ALGAE – ECONOMY BASED ECOLOGICAL SERVICE OF AQUATIC ECOSYSTEMS

LIFE17 ENV/LT/000407

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Actions in the projects

- Cyanobacteria blooms monitoring with the use of UAVs and satellite imagery.
- NDVI analysis and determination of the biomass content of cyanobacteria in water bodies.
- Determination of bloom areas.
- Identification of optimal times for cyanobacteria harvesting.
- Historical multi-temporal analysis using imaging series Sentinel-2.

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Spectral measurements

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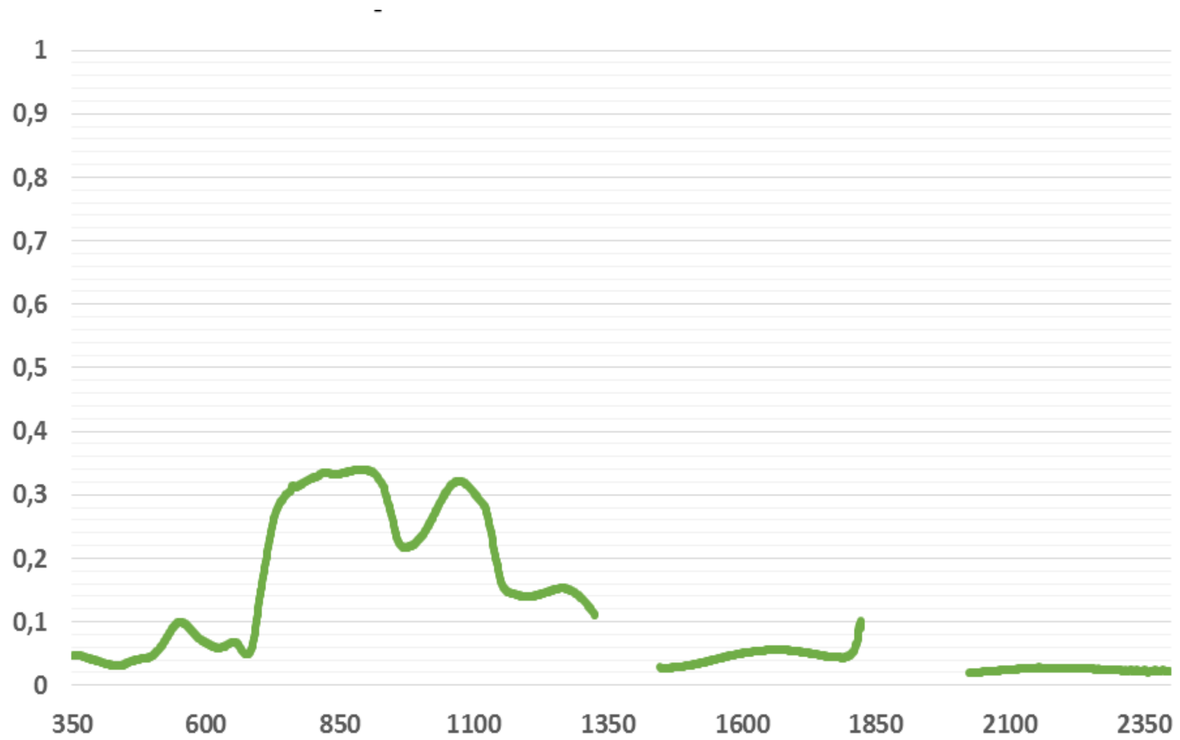
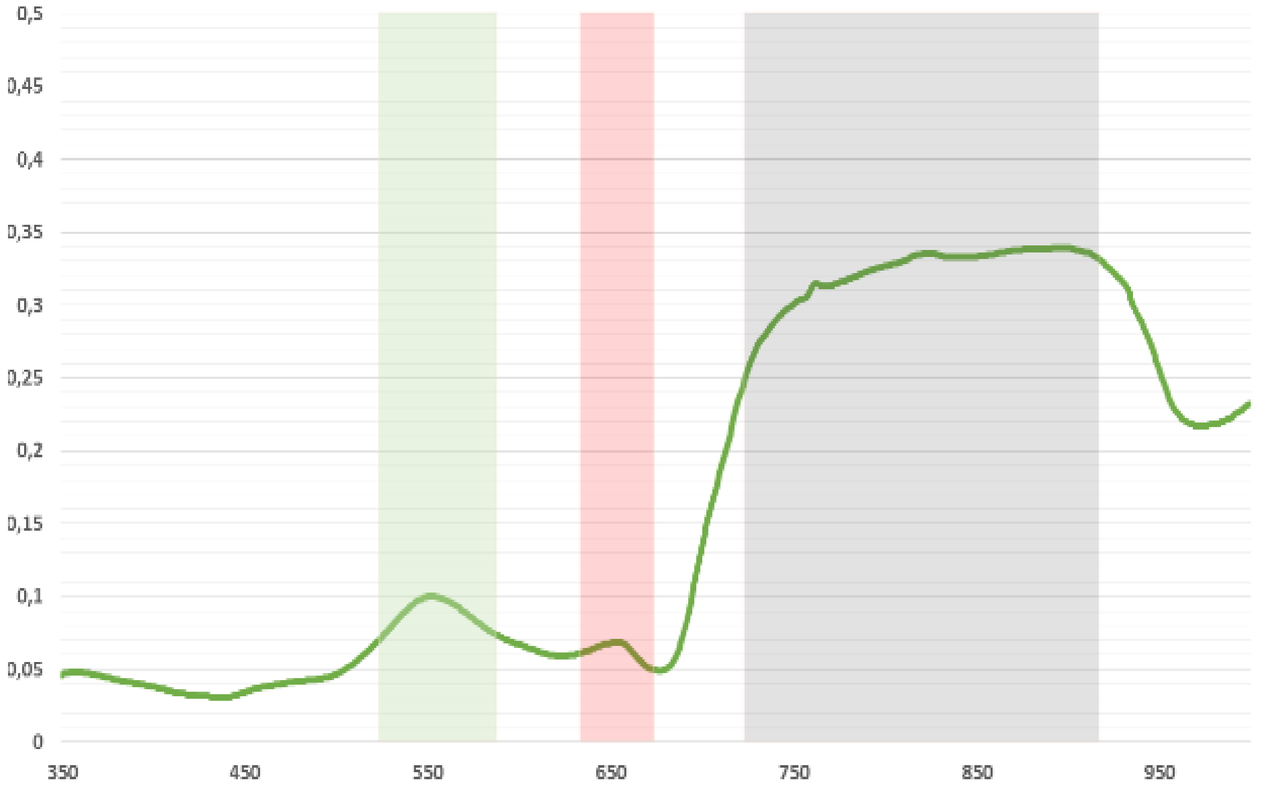
Reflectance measurements





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UAV Monitoring

2020 – MR UAV + 5 band multispectral camera + thermal camera

2021 – MR UAV + 10 band multispectral camera

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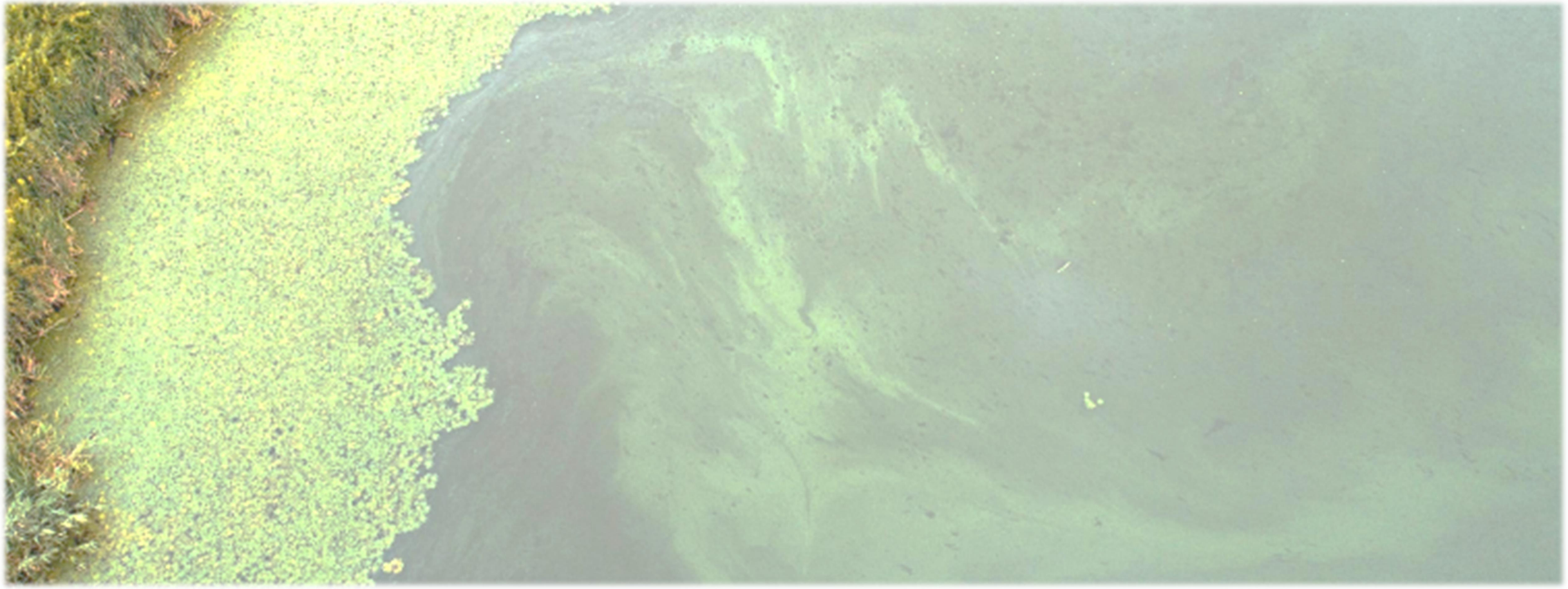
Data example – RGB imagery



Instytut Ochrony Przyrody PAN

Algae Service for Life

NFOŚiGW

Lietuvos Respublikos Aplinkos ministerija

Life

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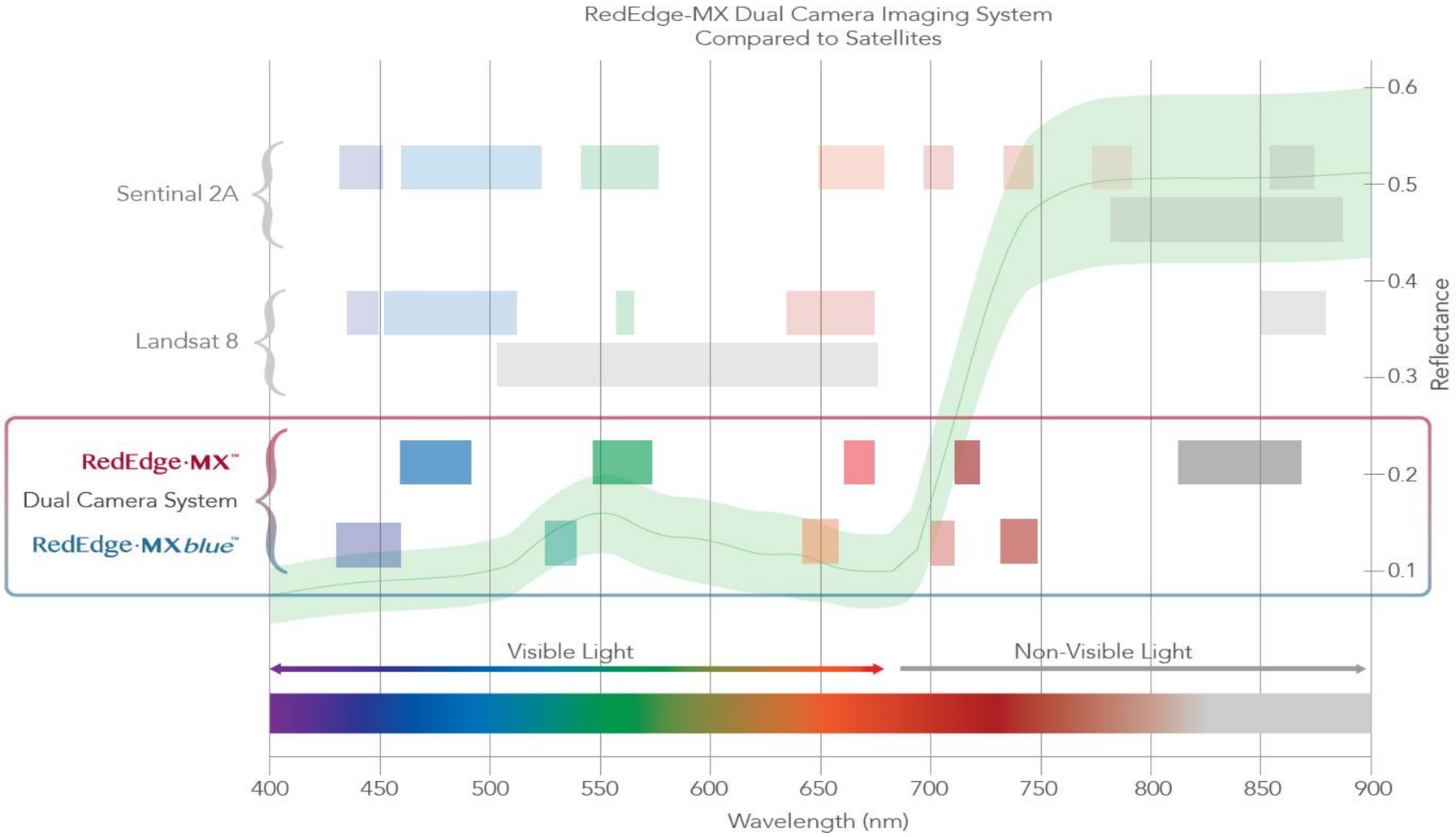
Sensors



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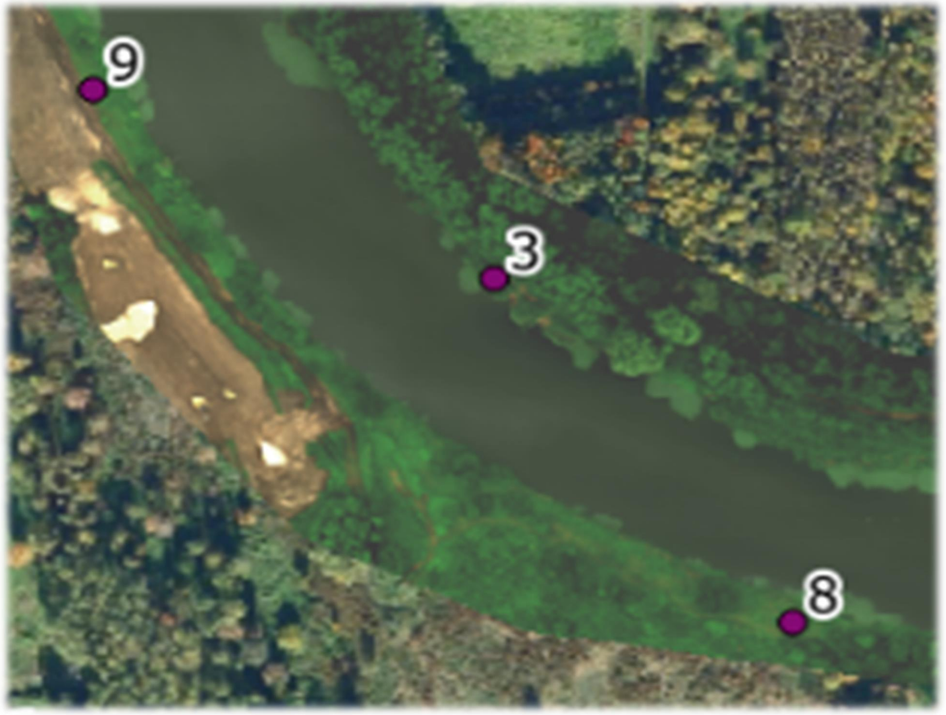
GCPs



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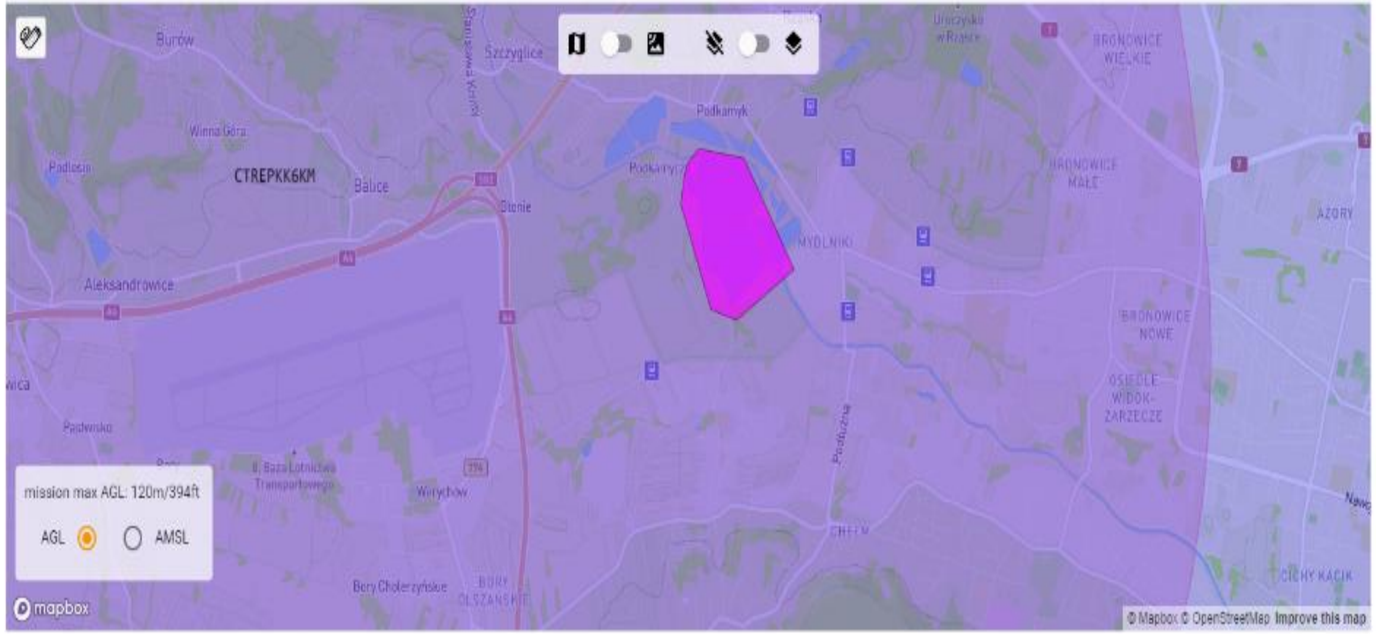
Main challenge – mission in Podkamycze – near EPKK airport

Dodano	Typ	Nazwa	Unit (PL)	Status
29-07-2020, 16:23:14	CTR	CTR EPKK	PANSA	accepted
29-07-2020, 16:23:14	CTR6KM	CTREPKK6KM	PANSA	accepted



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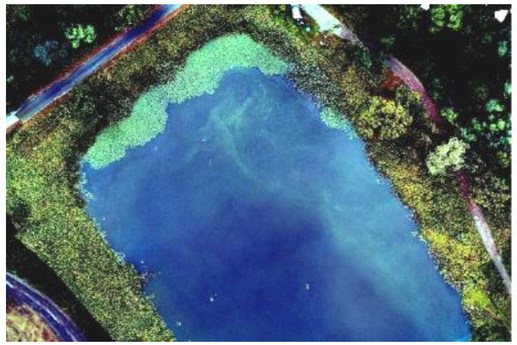
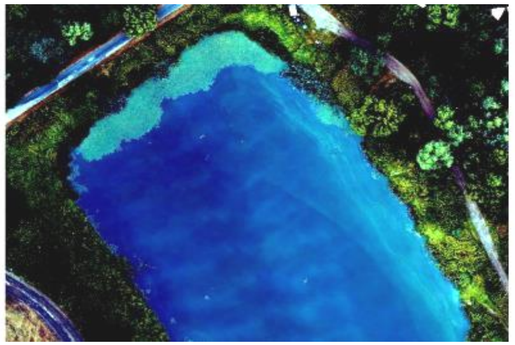
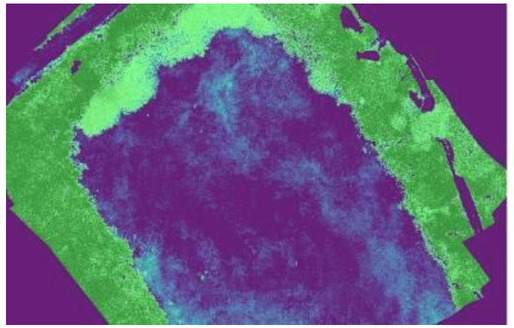
Specification of the best time of the day to acquire cyanobacteria – 10 AM, 11 AM, 1 PM

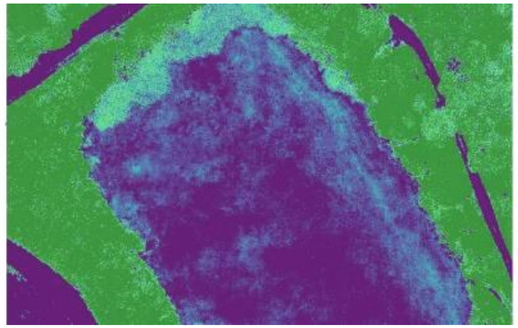
RGB

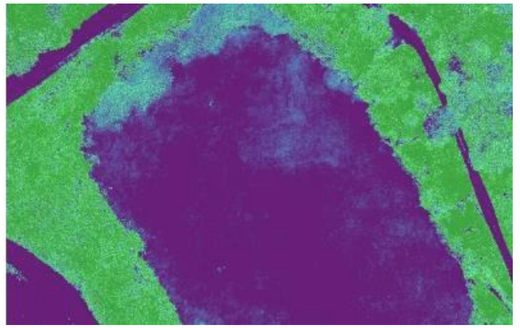




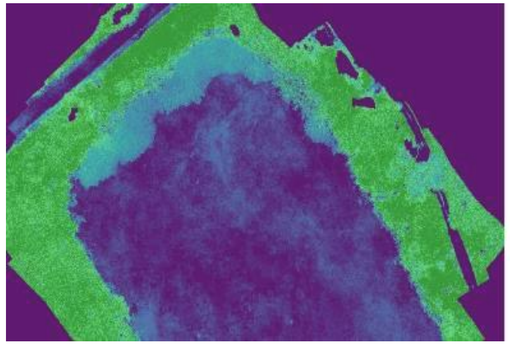
GLI

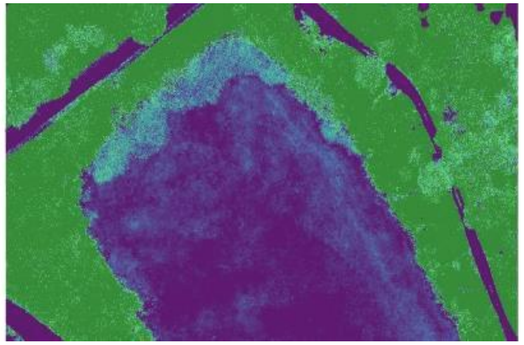


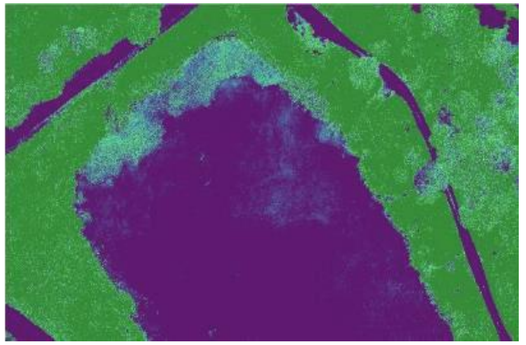




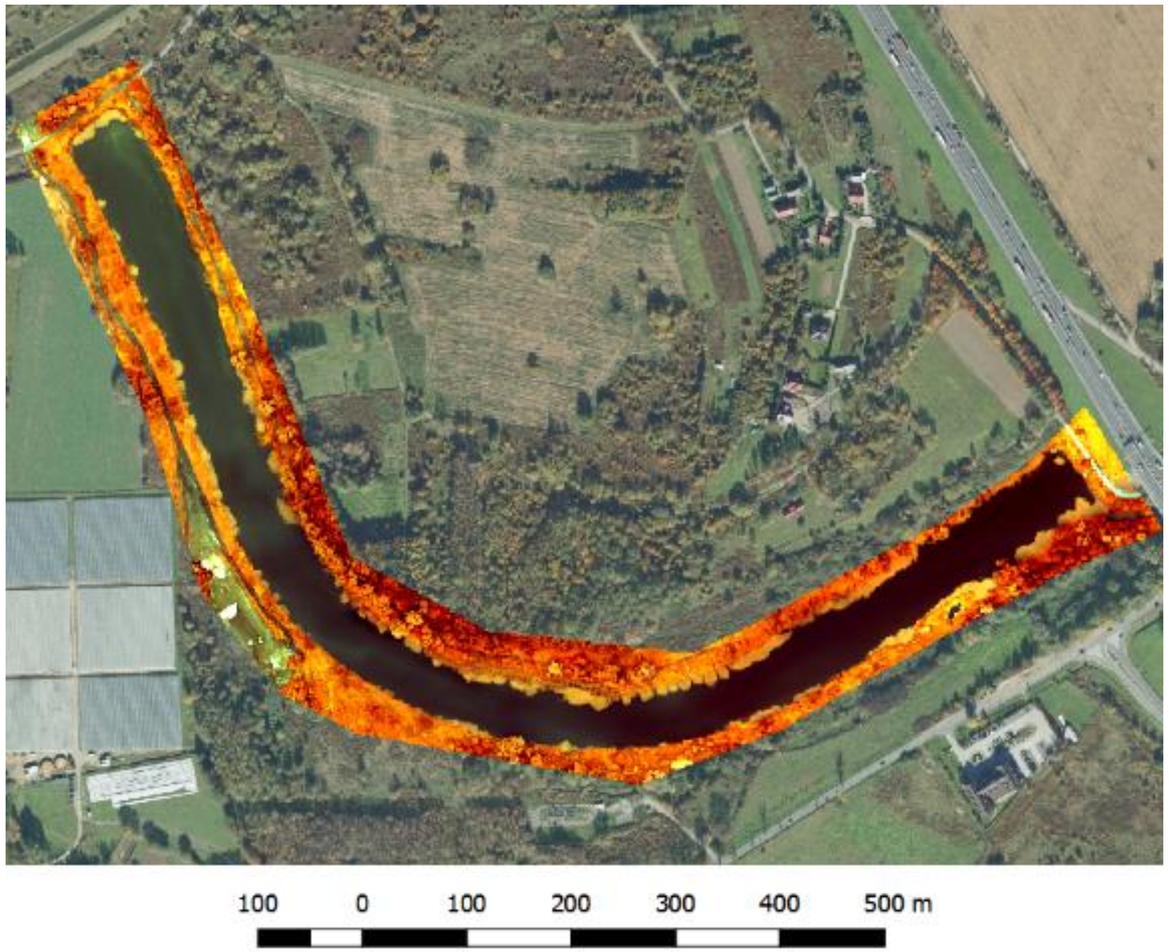
RGBVI

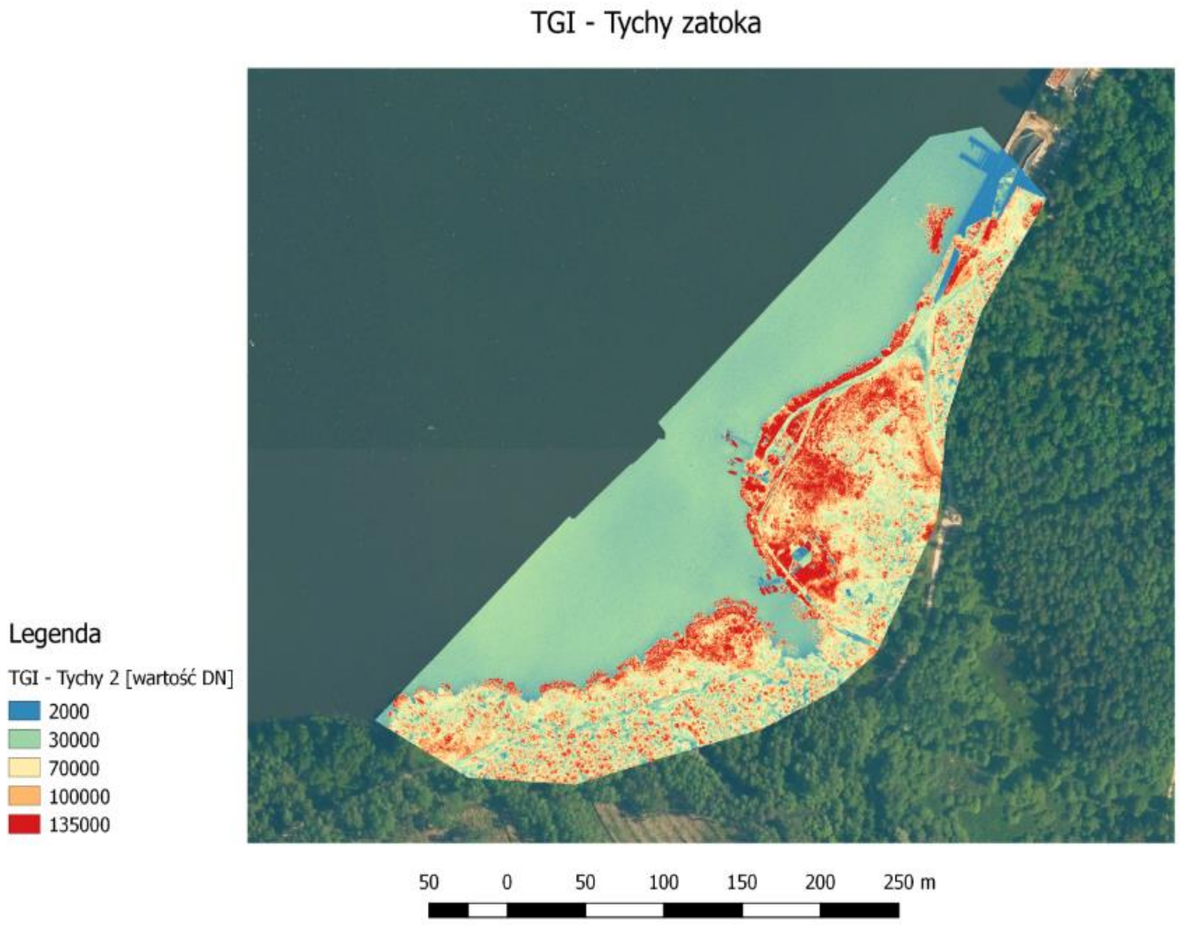






Results





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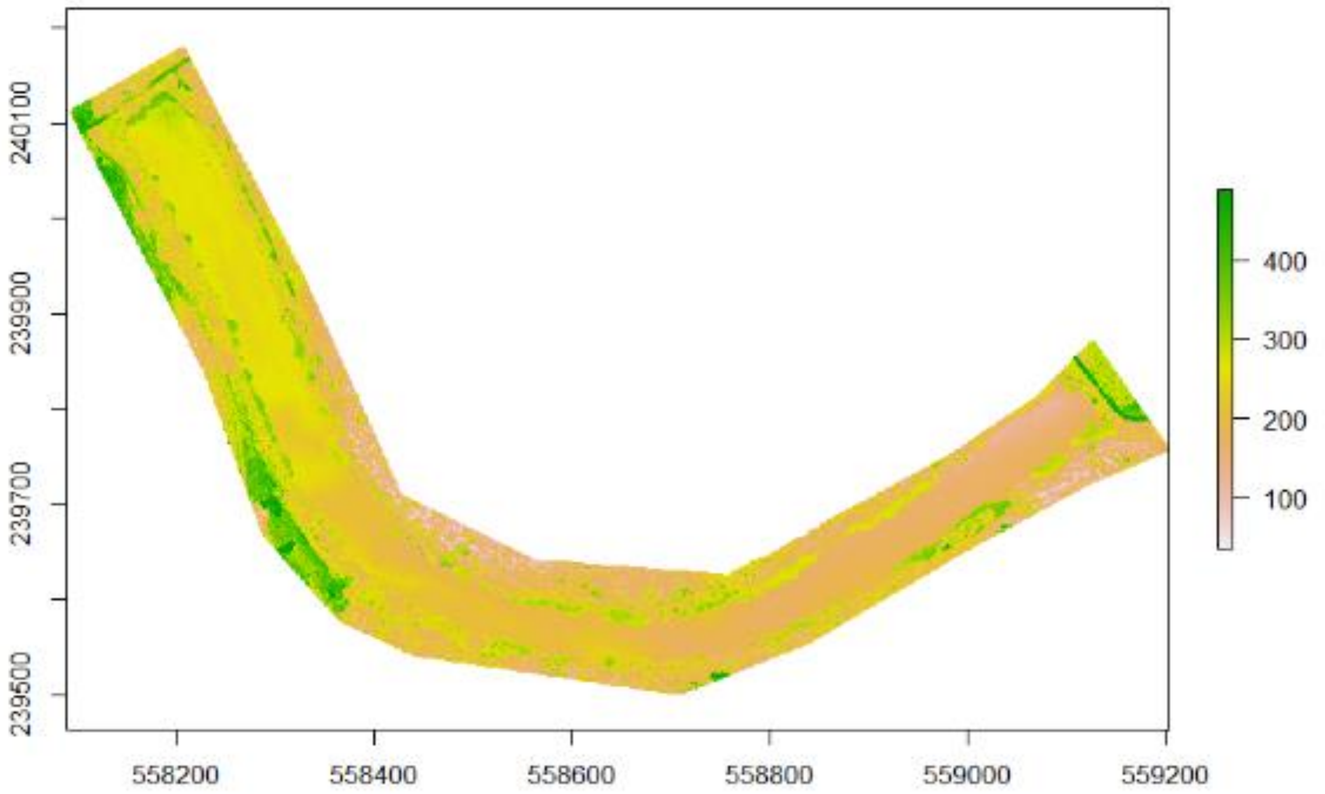
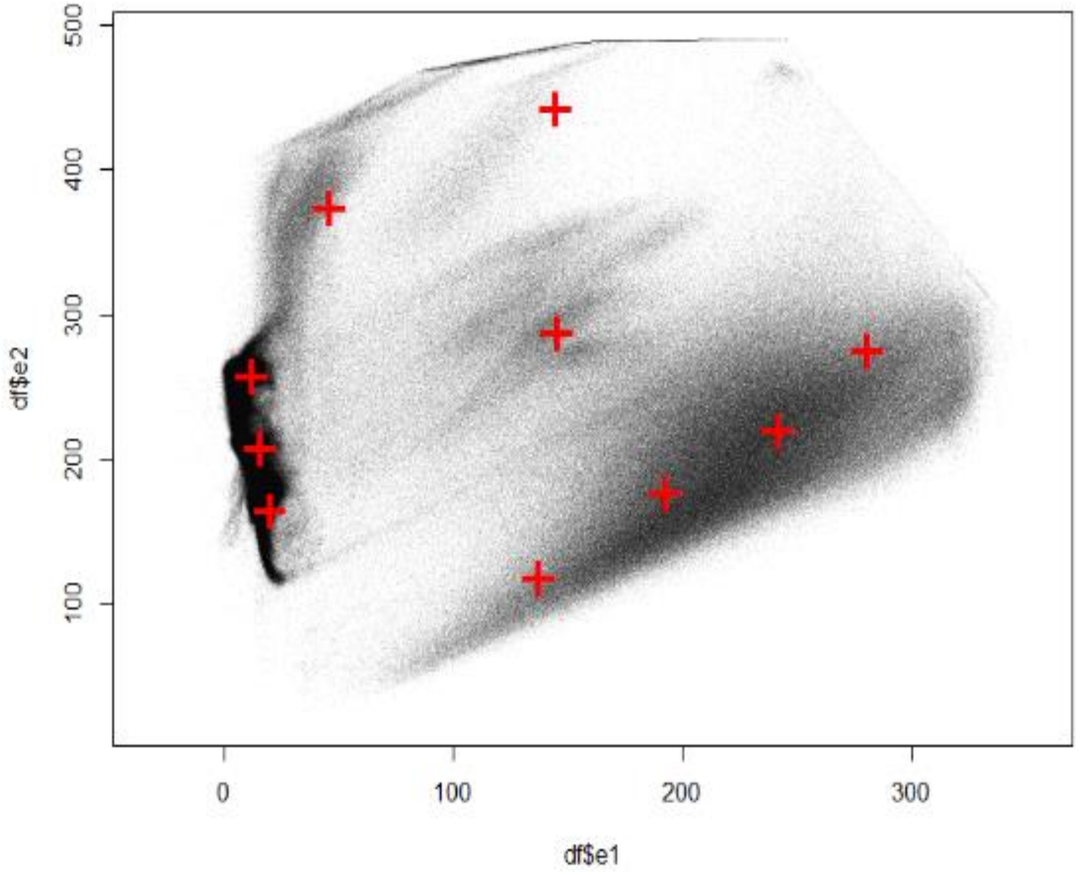
PCA Analysis





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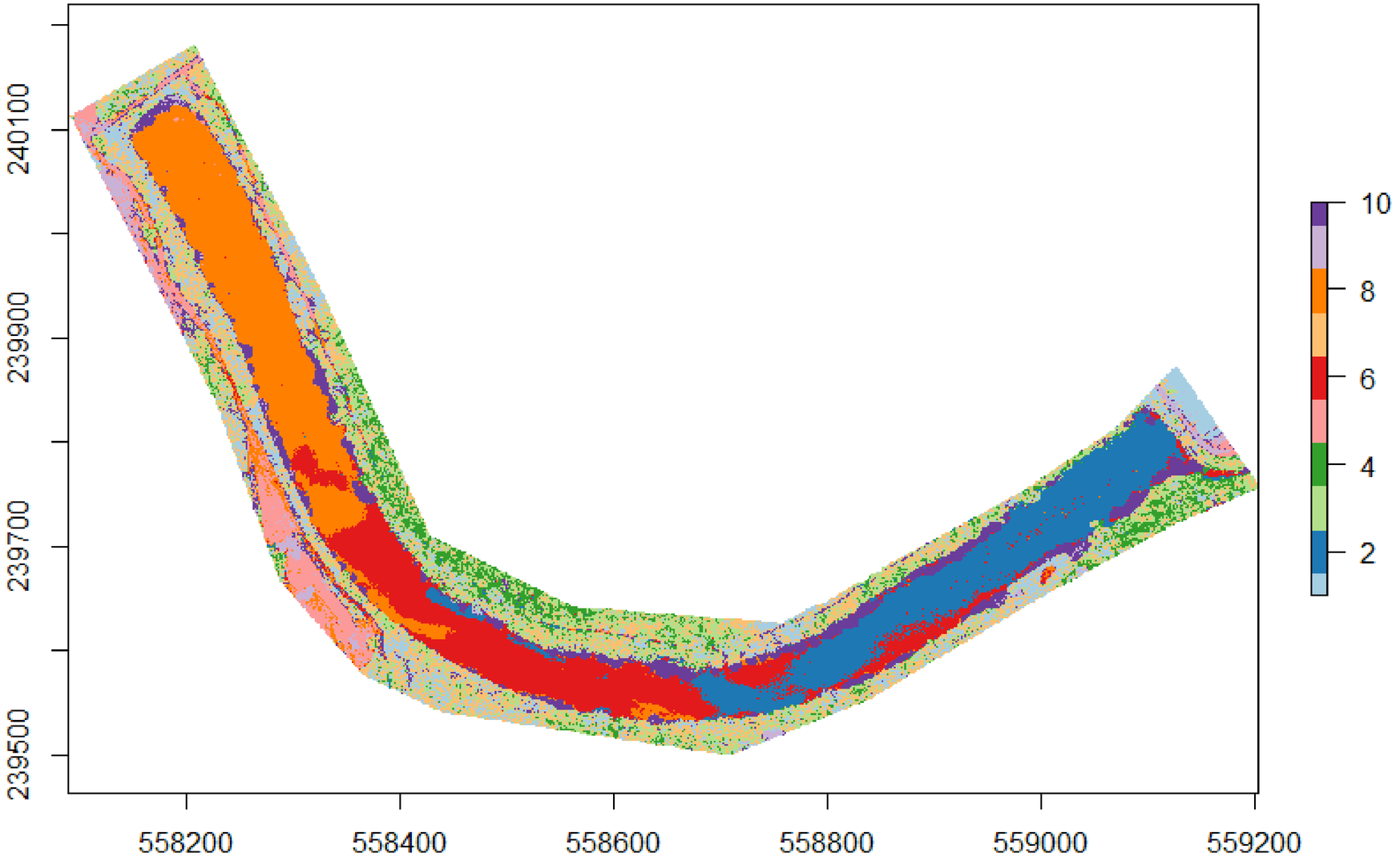
K-means clustering



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Proposed new RS index - GNCI

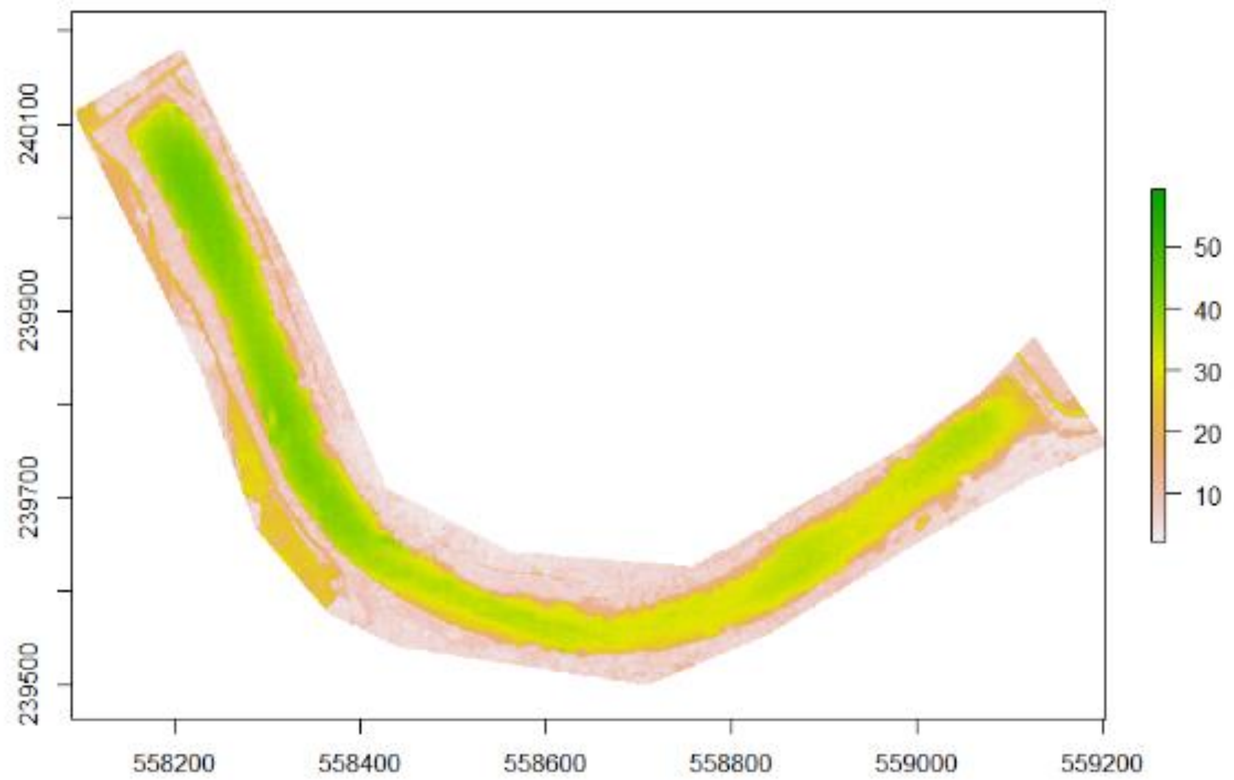
Green-NIR Cyanobacteria Index

NIR: 850 nm

Green: 560 nm

Author: Jan Kotlarz

$$10^{\left(1+\frac{Green-NIR}{NIR+Green}\right)}$$



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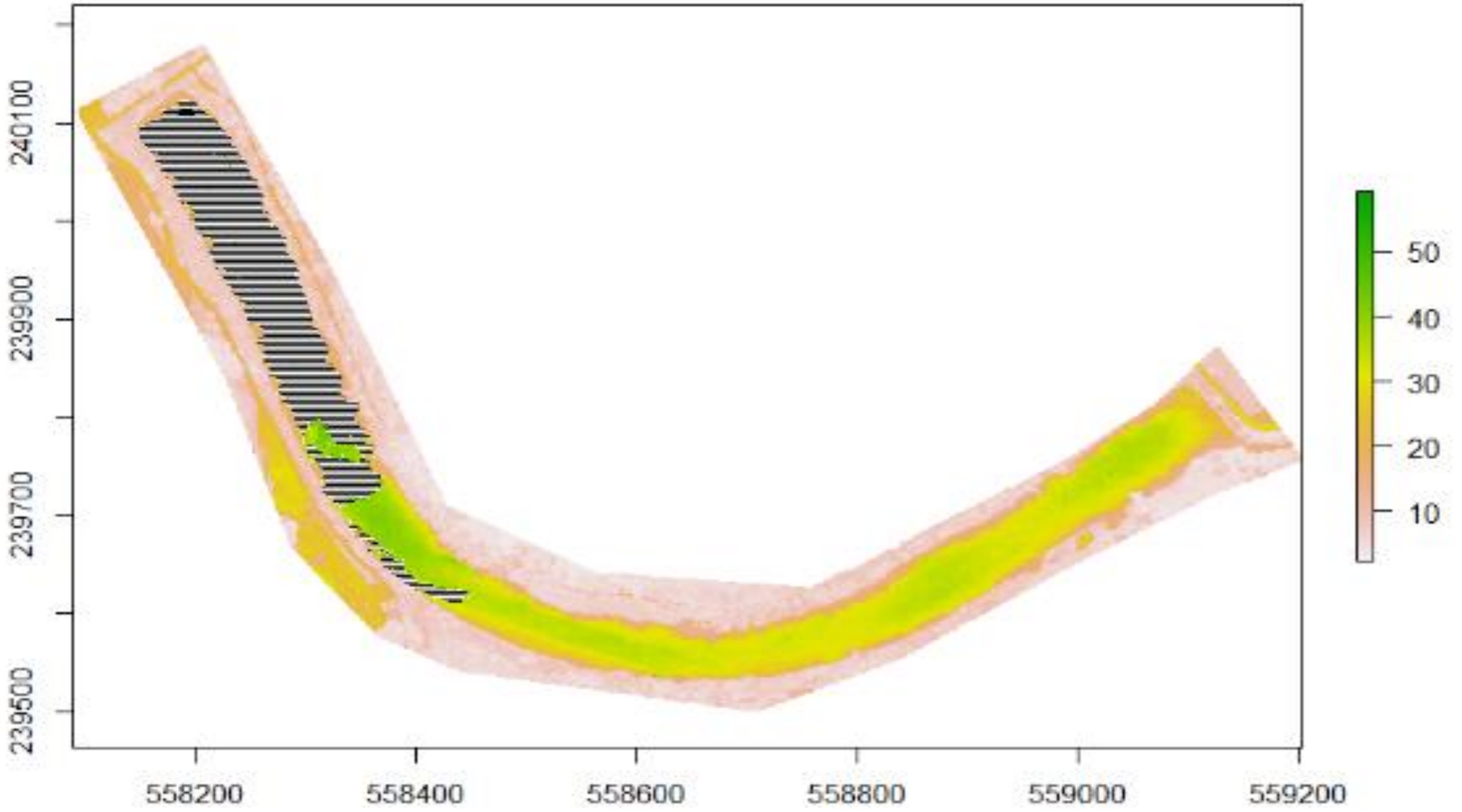
GNCI – bloom detection



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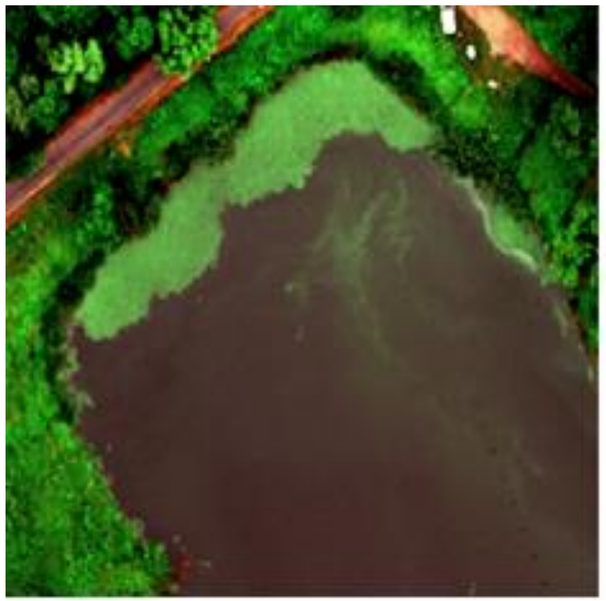
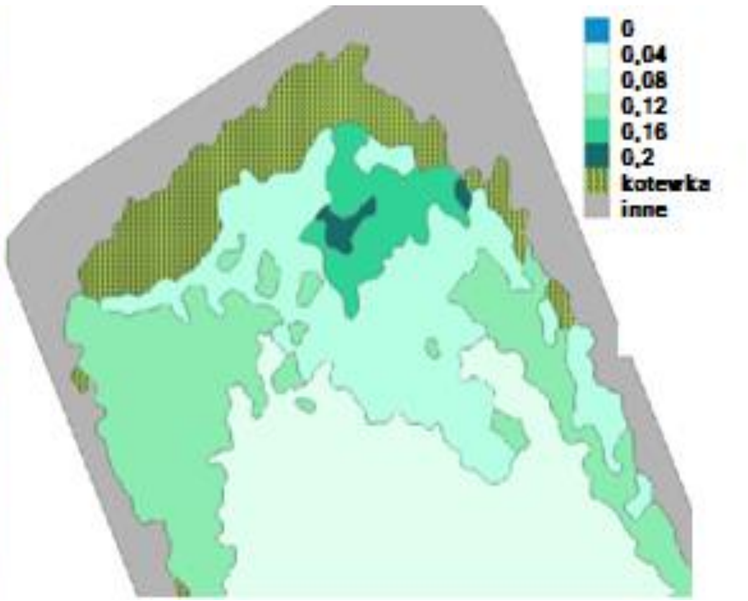
ML techniques – Random Trees – biomass amount estimation





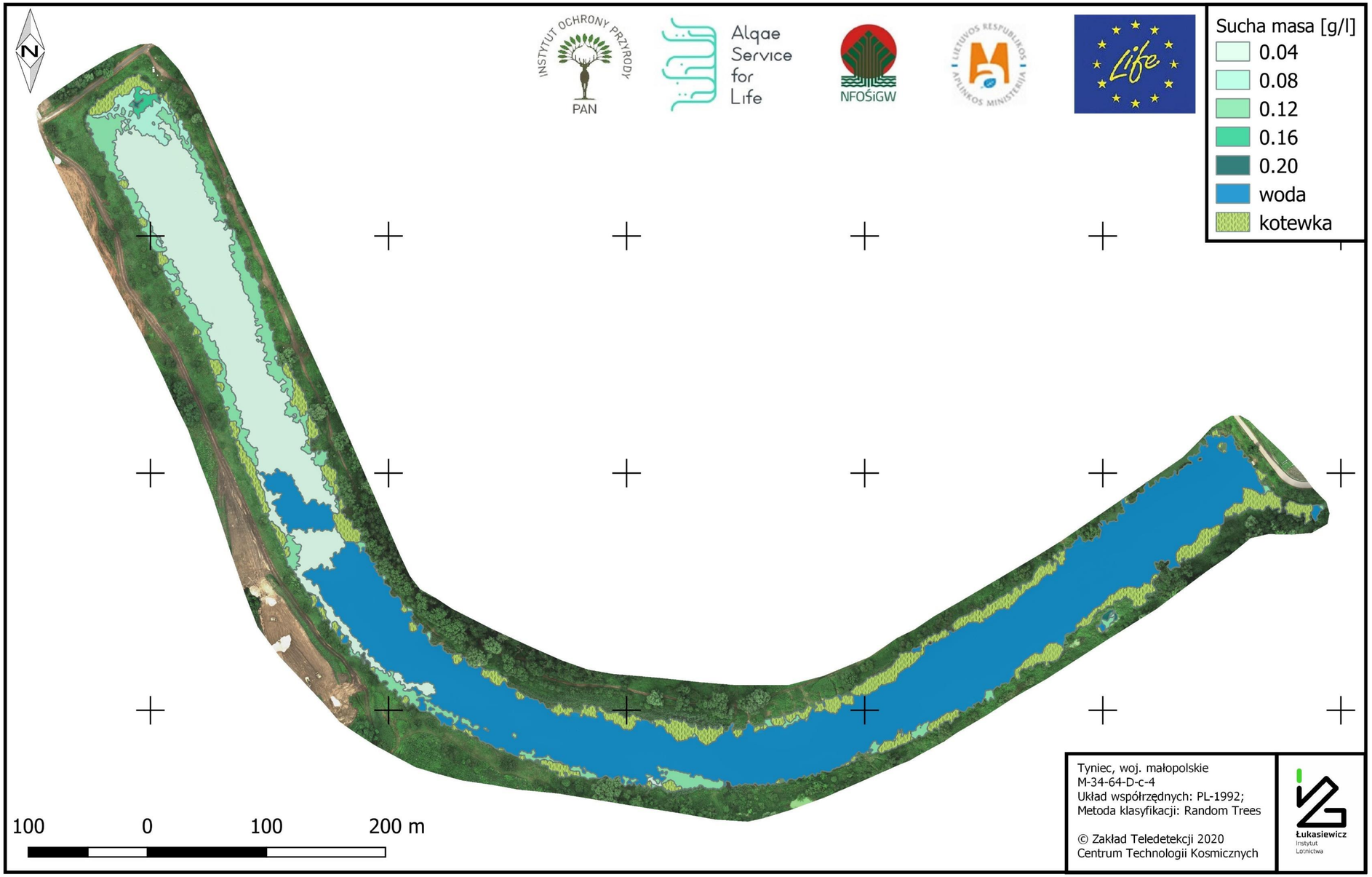
Cyanobacteria class [g/l]	Biomass amount [kg]	Area [m2]
0,04	7,13	17818,19
0,08	1,58	1313,39
0,12	15,07	7534,41
0,16	0,73	260,60
0,2	0,37	101,74
SUM	24,87	27028,34

Class	Area [m²]	Area percentage [%]
cyanobacteria	27028,3	27%
water	61254,1	62%
water caltrop	10826,2	11%

Accuracy assesment

Class	User accuracy	Algorithm accuracy
0	97.01%	94.54%
0,04	21.66%	15.66%
0,08	6.81%	64.28%
0,12	16.36%	94.73%
0,16	35.13%	72.22%
0,2	71.42%	37.03%
water caltrop	97.49%	92.77%
others	96.58%	97.14%
	Overall accuracy	93,19

Visualisation of estimated cyanobacteria dry mass amount in Tyniec with the use of Random Trees algorithm



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Satellite monitoring – Sentinel-2

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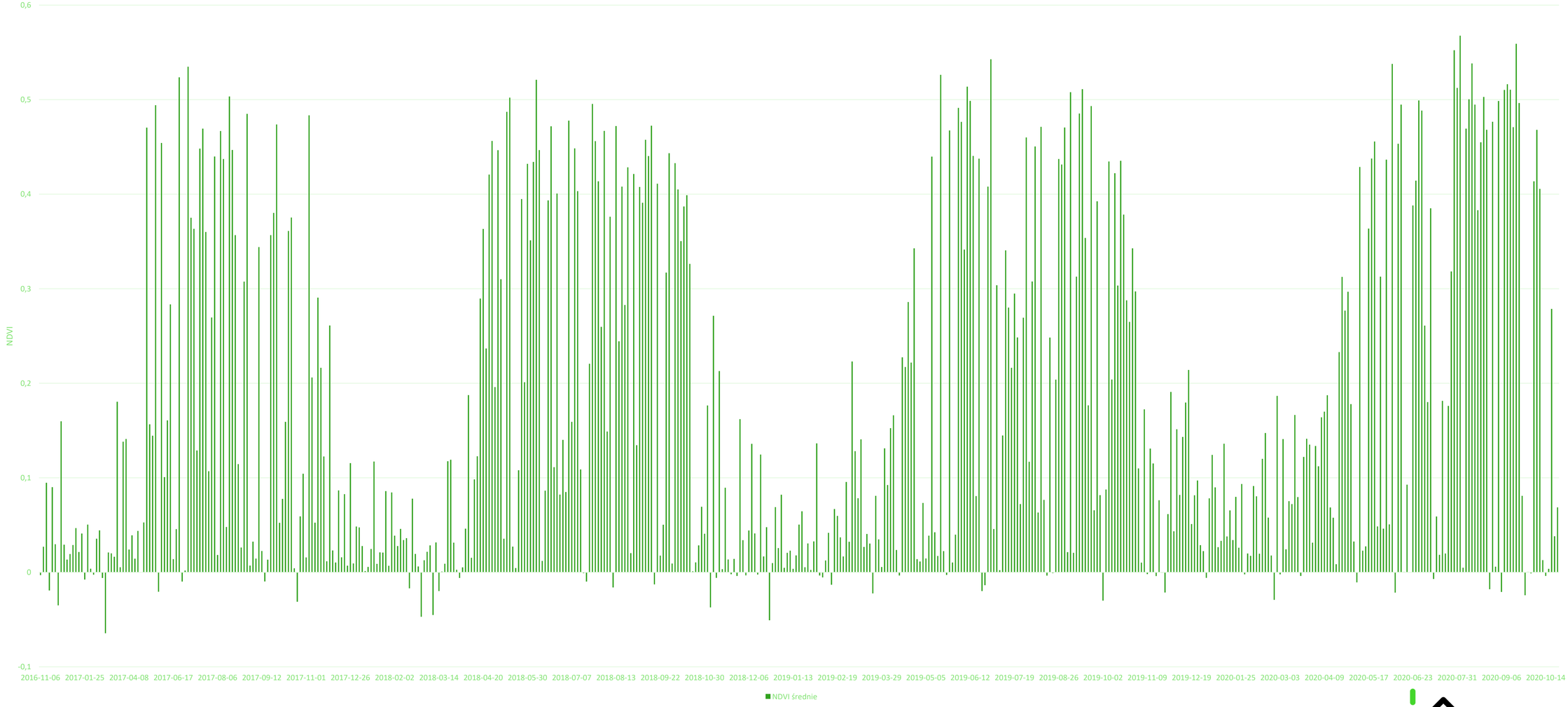
NDVI analysis (XI 2016-X 2020)



Correlation with chlorophyll-a measurement - 0,592

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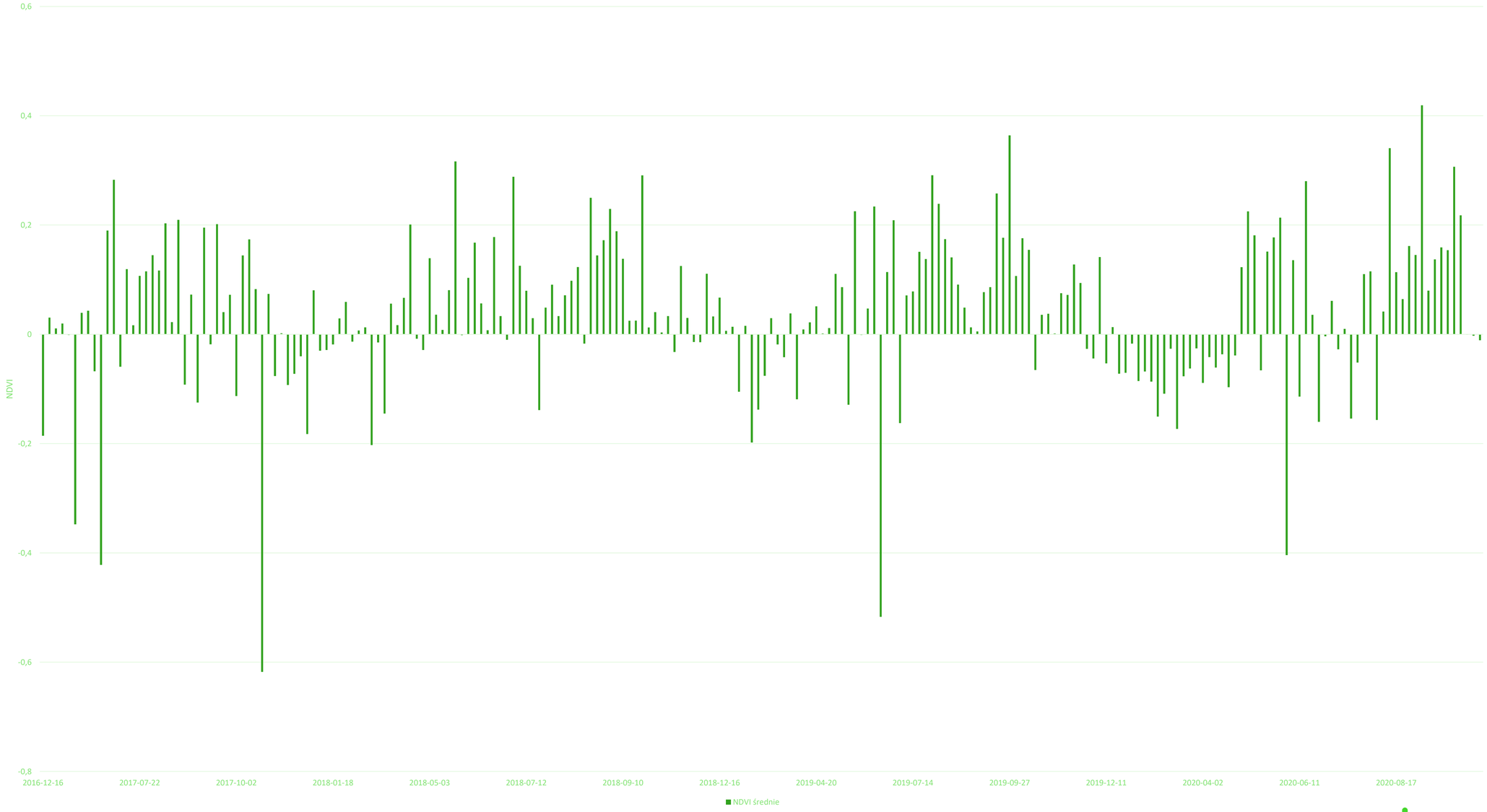
NDVI PODKAMYCZE



Correlation with chlorophyll-a measurement - 0,477

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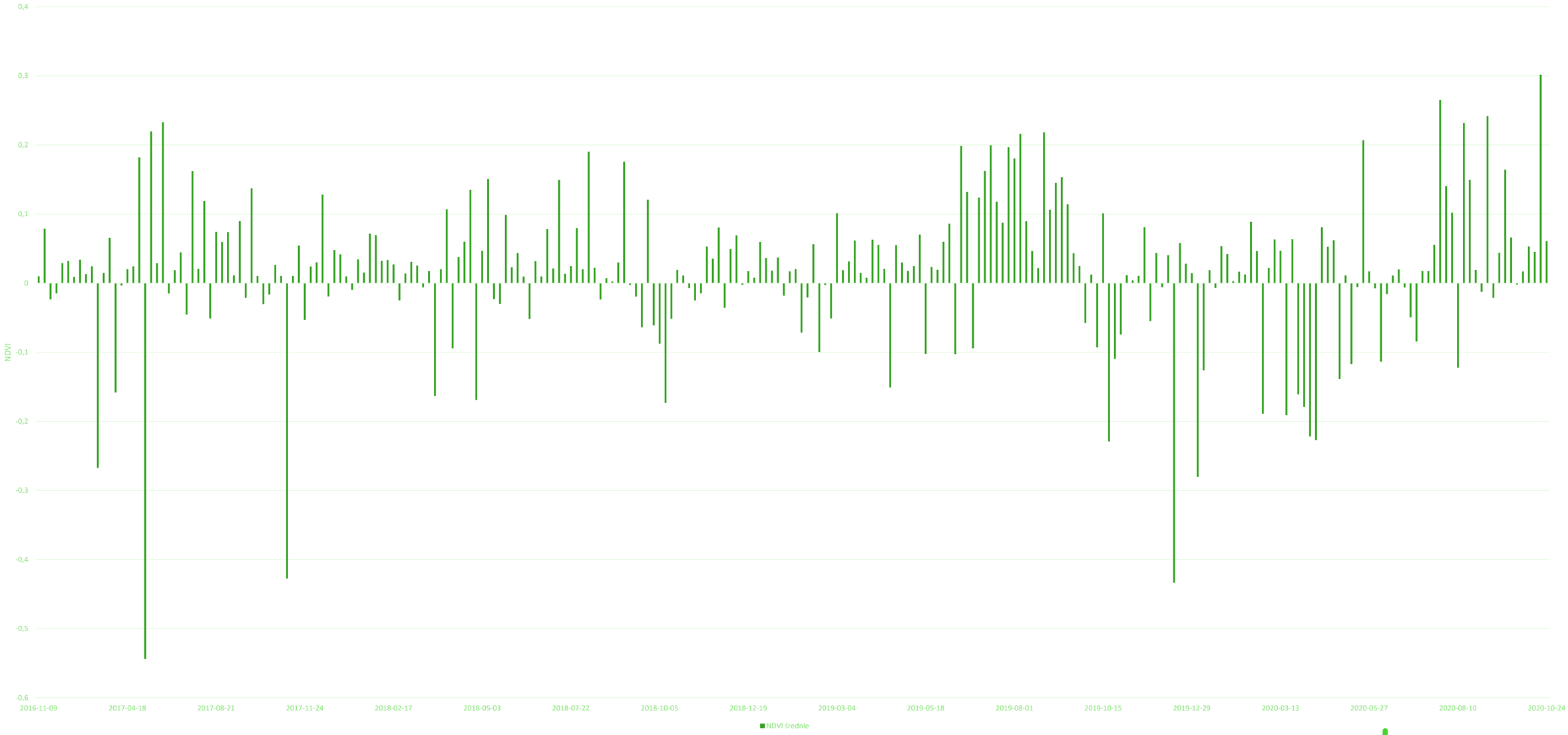
NDVI TYCHY



No historical chlorophyll-a measurement

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Summary

Usefulness

The study conducted within cooperation with IOP PAN confirmed the usefulness of using ground-based spectral data, aerial imagery and satellite imagery for remote sensing monitoring of cyanobacterial blooms.

Data Fusion

The best results are obtained by combining remote sensing methods based on data from three levels (ground, air and satellite). This gives the most complete information about the area. Such system should consist of: satellite imagery (assessment of blooms), meteo conditions (conditions for the development of cyanobacteria), aerial imagery (precise estimation of the amount of dry mass and absolute parameters), confirmed by field research (spectra signatures, samples).

Next steps?

Thank you very much for your attention!

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