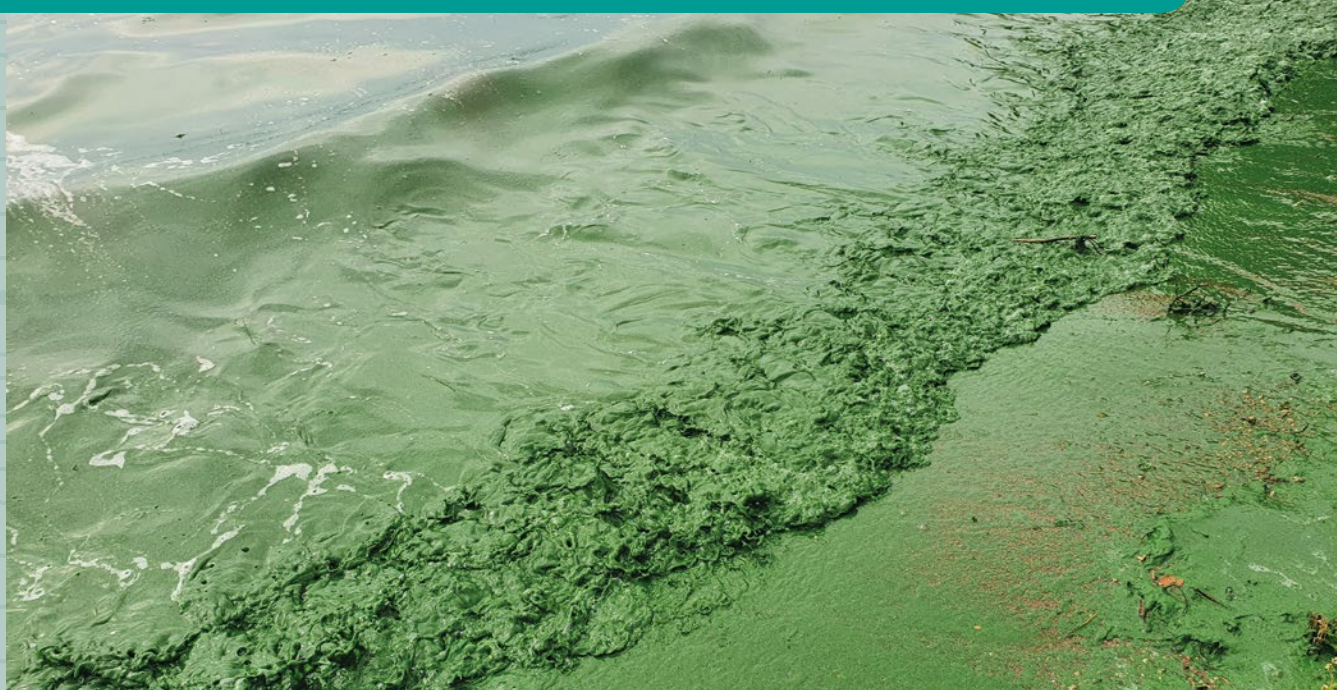
ALGAE – ECONOMY BASED
ECOLOGICAL SERVICE OF AQUATIC
ECOSYSTEMS

Alqae
Service
for
Life

CAN ALGAL BLOOMS BE CONTROLLED?



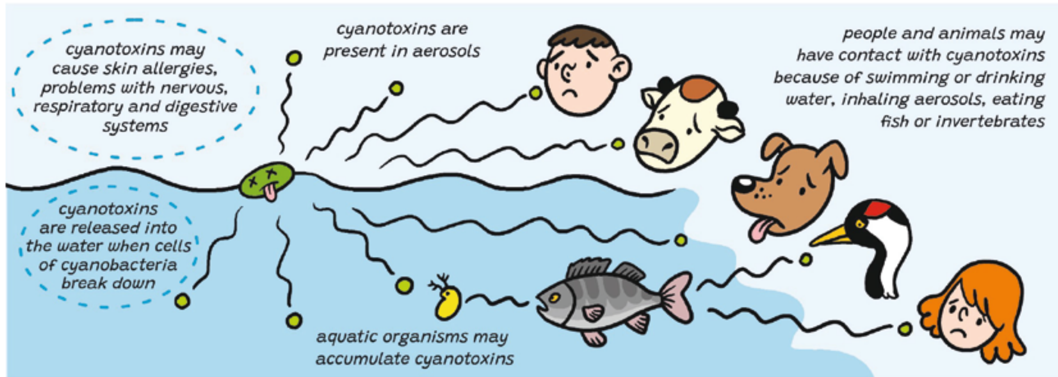
CONTENT

What are algal blooms? 1.

Due to growing human populations, many aquatic ecosystems face the challenge of accelerated loads of nitrogen and phosphorus that result in hyper-eutrophication. Enrichment by nutrients promotes the excessive production and uncontrolled growth of macroalgae and cyanobacteria (hereafter algae), these causing harmful blooms. The massive growth of these algae creates environmental and social problems due to formation of large mats and toxic scums in aquatic ecosystems.

Macroalgal agglomerations and cyanobacteria blooms impact water quality and lead to a reduction in biodiversity and heterogeneity of biotopes. In aquatic ecosystems, the decay of algal biomass results in oxygen depletion, promotes enrichment with nutrients and triggers an unpleasant smell. Furthermore, cyanobacteria produce a considerable range of cyanotoxins that can be of high risk to human health and even lead to the death of persons, wild animals and livestock. Harmful blooms also cause significant economic losses to water-related activities such as tourism, fisheries and other industrial sectors.

EFFECTS AND RISKS OF CYANOBACTERIAL TOXINS TO HUMAN, DOMESTIC ANIMALS AND WILDLIFE



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In the Baltic region, losses of nutrients from agriculture remain today the most important, but difficult to control, source of input to both freshwaters and to the Baltic Sea. Algae serve as a natural bio-filter that accumulates nitrogen, phosphorus and CO_2. Therefore, harvesting this excessive level of biomass in aquatic ecosystems could be an efficient tool in reducing the aquatic nutrient load.

The project “Algae – Economy Based Ecological Service of Aquatic Ecosystems” (LIFE17 ENV/LT/000407, AlgaeService for LIFE) demonstrates newly created prototypes for the collection of excess algal biomass in aquatic ecosystems, harvesting these as a source of phosphorus and nitrogen, while at the same time reducing the amount of hazardous cyanotoxins and focussing on mitigating the impacts of nutrient increase and reducing the risk of blooms. It is a step towards the creation of a circular economy model for the redesigning of waste harvested biomass into potentially valuable products for sustainable management and for the recycling of environmental resources.

The project seeks to promote best practices in ecological service and the circular economy approach by implementing an innovative complex system which is of both demonstration and innovation character.

THE OBJECTIVES OF THE PROJECT

1. To demonstrate integrated efficient management of nutrients and algal blooms through the harvesting of macroalgae mats and cyanobacteria scums;
2. To test and demonstrate the redesigning of harvested biomass into potentially valuable products;
3. To raise awareness to environmental, water quality and health hazard issues among national governments, local authorities, the business community and society.

Where is algal biomass collected?

2.

Initiating this project, water bodies of different types and sizes (rivers, lakes, oxbow lakes, ponds, Kaunas Reservoir and the Curonian Lagoon) were chosen in Lithuania and Poland. All of the water bodies are in the catchments of rivers flowing into the Baltic Sea and, therefore, the collection of algal biomass will lead not only to cleaner inland water bodies, but also the Baltic Sea.

WATER BODIES SELECTED FOR MACROALGAE AND CYANOBACTERIA HARVESTING

MACROALGAE

LAKES:	*Oporzyńskie* *Łęgowskie*
RIVERS:	*Šventoji* *Dubysa* *Jūra* *Nevėžis* *Nielba* *Wełna*

CYANOBACTERIA

LAKES:	*Simnas* *Paprocańskie* *Tynieckie* *Łeknińskie*
PONDS:	*Podkamycze-1* *Podkamycze-2*
KAUNAS RESERVOIR	
CURONIAN LAGOON	


Lake Oporzyńskie

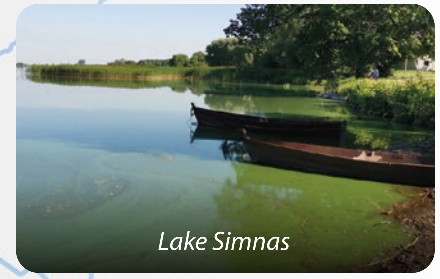

Lake Łęgowskie


River Nielba

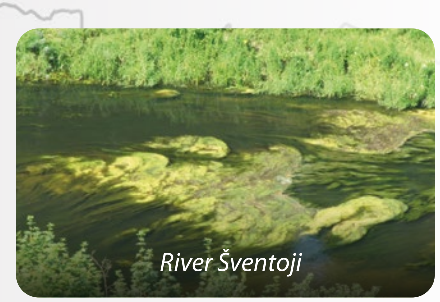

Lake Podkamycze


Lake Tynieckie


Curonian Lagoon


Lake Simnas


Kaunas Reservoir


River Šventoji


River Nevėžis

3. What is the water quality of selected water bodies?

The monitoring of water quality is an important step in the assessment the effect of applied measures in selected ecosystems and for the evaluation of the potential to manage environmental changes. For this project, physico-chemical water (temperature, transparency, pH, conductivity, total nitrogen and total phosphorus) and biological (chlorophyll-*a*, phytoplankton, macroalgae, cyanotoxins, zooplankton, zoobenthos, macrophytes) parameters were obtained in the course of baseline monitoring of the selected ecosystems (2018–2020), with historical monitoring data also exploited. The baseline data will serve as a reference point for the evaluation of changes in the physico-chemical and biological parameters after algal biomass harvesting in 2021–2023. In total, over 9000 samples and measurements were analysed. Carbon, phosphorus, nitrogen and cyanotoxins assessed in the algal biomass will be used for the evaluation of the total amount of nutrients and toxins removed from the water bodies via harvesting.

The ecological status of the tested aquatic ecosystems was assessed based on the requirements of the Water Framework Directive and the legislation of the two countries. All of the selected water bodies were identified as being at risk, except the River Dubysa and Podkamycze-1 pond. Water quality was mainly affected by agricultural run-off, urban and wastewater discharges and recreation.

MEASUREMENTS OF PHYSICO-CHEMICAL WATER PARAMETERS AND COLLECTION OF SAMPLES

ECOLOGICAL STATUS OF THE TESTED WATER BODIES IN 2019–2020

Ecological status: *Very good* · *Good* · *Moderate* · *Bad* · *Very bad* · *Worse than good status*

COUNTRY	WATER BODY	PHYSICAL-CHEMICAL PARAMETERS			BIOLOGICAL PARAMETERS
		TN	TP	Water transparency	Chlorophyll-*a* / PMPL indexes
LITHUANIA	Lake Simnas	Moderate	Bad	Very bad	Very bad
	Kaunas Reservoir	Good	Very bad	–	Very bad
	Curonian Lagoon	Very bad	Moderate	–	Moderate
POLAND	Lake Oporzyńskie	Worse than good status	Worse than good status	Worse than good status	Very bad
	Pond Podkamycze-1	Worse than good status	Worse than good status	Worse than good status	Good
	Pond Podkamycze-2	Worse than good status	Worse than good status	Worse than good status	Very bad
	Oxbow Tynieckie Circle	Worse than good status	Worse than good status	Worse than good status	Very bad

TN – total nitrogen (mg/l); TP – total phosphorus (mg/l); water transparency – Secchi disk, m; Chlorophyl-a index – counted based on chlorophyll-a value in Lithuania; PMPL index – Phytoplankton Metric for Polish Lakes index counted based on chlorophyll-a value and biomass of phytoplankton and cyanobacteria metrics; "– " – no data

COUNTRY	RIVER	PHYSICAL-CHEMICAL PARAMETERS						BIOLOGICAL PARAMETERS
		BN	NO_3^-	NH_4^+	BP	PO_4^{3-}	O_2	MIR index
LITHUANIA	Dubysa	Very good	Very good	Very good	Very good	Very good	Very good	Good
	Jūra	Very good	Very good	Very good	Very good	Very good	Very good	Very bad
	Nevėžis	Moderate	Bad	Good	Very bad	Very bad	Very good	Very bad
	Šventoji	Very good	Very good	Very good	Very good	Very good	Very good	Very bad
POLAND	Nielba	Very good	Very good	Very bad	Very bad	Very bad	Very good	Very bad

TN – total nitrogen (mg/l); NO_3^- – nitrate-nitrogen (mg/l); NH_4^+ – ammonium-nitrogen (mg/l); TP – total phosphorus (mg/l); PO_4^{3-} – phosphate-phosphorus (mg/l); O_2 – dissolved oxygen (mg/l); MIR index – Macrophyte Index for Rivers

Two groups of cyanobacteria toxins (hepatotoxins and neurotoxins) were detected in the water and in the biomass of the cyanobacteria in the tested aquatic ecosystems. In Kaunas Reservoir and the Curonian Lagoon, the concentration of hepatotoxic microcystins exceeded the guidance level of 24 µg/l for recreational water use as proposed by the World Health Organisation (WHO, 2020). In extensive cyanobacterial scums, the concentration of cyanotoxins in Lake Simnas and Kaunas Reservoir was more than 100 µg/l and posed a serious risk to humans and the biota.

THE HIGHEST CONCENTRATION OF CYANOTOXINS DETERMINED IN THE TESTED AQUATIC ECOSYSTEMS

	IN WATER	IN BIOMASS	GUIDANCE LEVEL *(WHO, 2020)*
HEPATOTOXINS	**Microcystins** *Simnas 2.40 µg/l* *Kaunas Reservoir >50 µg/l* *Podkamycze-1 0.67 µg/l* *Podkamycze-2 6.42 µg/l* *Oxbow Tynieckie 17.97 µg/l*	**Microcystins** *Simnas 2.31 µg/l* *Kaunas Reservoir > 50 µg/l* *Curonian lagoon 134.25 µg/l* *Podkamycze-2 7.49 µg/l* *Oxbow Tynieckie 12.07 µg/l* *Paprocany 0.73 µg/l* **Nodularin** *Curonian lagoon 284.6 µg/l*	**Microcystin-LR** *Drinking water 1 µg/l* *Recreational water 24 µg/l*
NEUROTOXINS	**Anatoxin** *Simnas 4.57 µg/l* *Kaunas Reservoir 0.18 µg/l* *Oxbow Tynieckie 0.32 µg/l* **Saxitoxin** *Simnas 0.010 µg/l*	**Anatoxin** *Simnas 4.29 µg/l* *Kaunas Reservoir 0.02 µg/l* **Saxitoxin** *Simnas 0.003 µg/l*	**Anatoxin** *Drinking water 30 µg/l* *Recreational water 60 µg/l* **Saxitoxin** *Drinking water 3 µg/l* *Recreational water 30 µg/l*

How do you identify hotspots of algal biomass distribution? 4.

Traditional phycological methods and remote technologies are used to identify hotspots of algal biomass agglomerations in the water bodies. Data on algal agglomerations in the selected water bodies is necessary for the preparation of monitoring methodology and the optimisation of the harvesting protocol.

METHODS FOR DEFINING ALGAL BLOOMS

Traditional phycological methods

Time and labour consuming: require frequent field visits, sampling and microscopic analysis

Up-to-date remote technology methods

Use the light spectral bands and band ratios to construct algortihms as modelled indicators of chlorophyll-a

PREPARATION OF NEW METHODOLOGY

New efficient methodology for monitoring of algal blooms in inland water ecosystems

Cost-efficient harvesting of wild algal biomass

Remote methods are a new tool for the monitoring of eutrophication events in surface water bodies. As the appearance of hotspots of mats and scums is difficult to predict due morphological characteristics (size, depth, curvature, etc.) of the water body and environmental variables (seasonal timing, temperature, wind direction, etc.), the application of distant methods allows the rapid identification of locations of sufficient algal agglomerations for harvesting and to determine the best period for biomass collection with the least time input, thus in this way it can be an economically feasible solution. Although satellites can provide high resolution images, it is too costly to use this technology for the detection of algae in small water bodies. In these cases, unmanned aerial vehicles (UAV) can be utilised. Satellite images can be used for monitoring large water ecosystems such as the Curonian Lagoon.

Evaluation of macroalgal agglomerations using UAV images in Lithuania. Remote studies of rivers (on about 100 km of selected reference sections) and open water areas of lakes were carried out using an unmanned aerial system that consisted of a fixed-wing UAV and built-in visual or infrared spectral cameras. Prior to implementation, the best hydrometeorological conditions suitable for the maximum accuracy of the results of remote sensing of algae and the minimum impact of possible disturbances were determined. The aerial photography data was complemented by thermographic scanning of the study area.

The preparation and analysis of the collected material included three steps:

1. Building an orthophotomosaic was performed by combining a set of aerial photographs;
2. Analysis of raster images was conducted based on different colour characteristics of the aerial photographs. Heterogeneous areas (e.g. algae on the surface, algae on the bottom, sandy bottom) were identified and grouped in accordance with the turbidity data. On the basis of the classification, as well as expert opinion and direct studies, polygons were automatically assigned to one of the classification types using software;
3. An inventory of algal agglomerations was carried out using ArcGIS software according to a number of parameters (e.g. the area and volume occupied by algae, hotspots of agglomerations). Raster segmentation and classification of the orthophoto maps of the studied channels allow the effective identification of river sections with different concentrations of algae and the calculation of their amount. Transparency, insolation and the degree of shading of the water surface were the main limiting factors for the accuracy of the study.

Riverbed scanning using an infrared wave (thermal imaging) sensor confirmed the results obtained from the visual spectrum orthophotography analysis and captured the polygons with the highest concentrations of macroalgae, these being closely related to morphological features of the riverbed.

METHODOLOGY OF EVALUATION OF ALGAL AGGLOMERATIONS USING UAV IMAGES

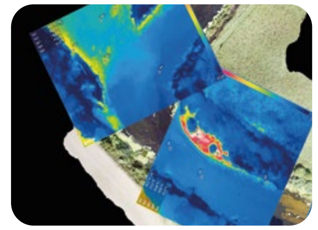
UAV takes images

UAV image of the river segment

Identification of areas based on turbidity and grouping

In situ analysis

Raster segmentation of the riverbed



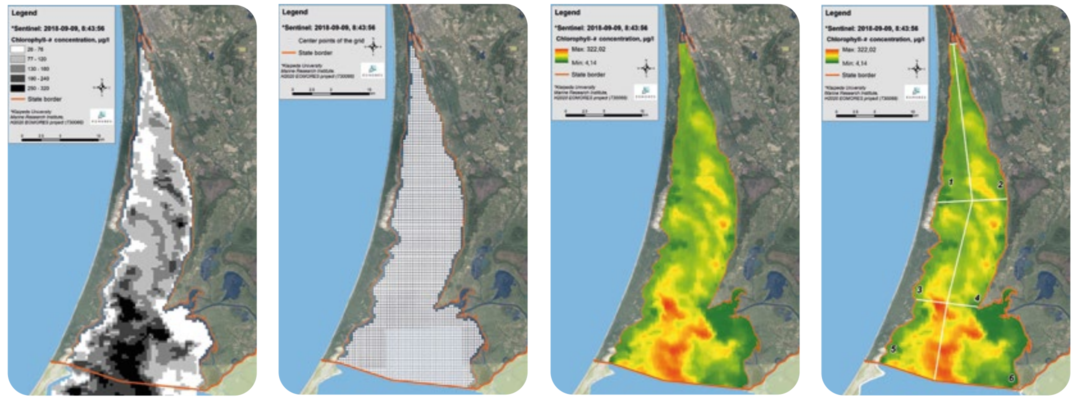
Thermographic scanning

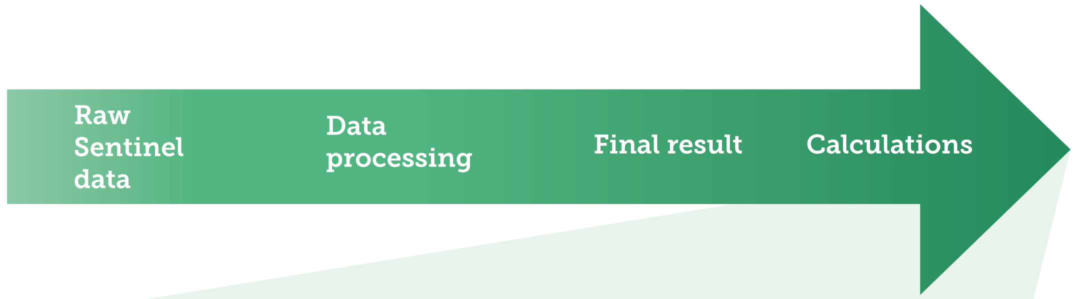
River	Length of the stretch, km	Macroalgae agglomerations		
		area covered, ha	total weight, t	average weight, kg/m³
Šventoji	12.7	128.5	3276.8	2.55
Dubysa	14.0	22.3	1264.5	5.67
Nevėžis	6.9	118.3	6234.4	5.27
In total:	**33.6**	**269.1**	**10775.7**	**4.34±1.64***

*average ± SD

Evaluation of cyanobacteria blooms using satellite images in the Curonian Lagoon. Cyanobacteria blooms were evaluated in cooperation with Klaipėda University in the frame of the Horizon 2020 project EOMORES. They developed a series of services for monitoring the quality of inland and coastal water bodies based on a combination of the most up-to-date satellite data, innovative *in situ* instruments. Using the proposed tool for measuring the chlorophyll-*a* concentration, hotspots of cyanobacteria blooms in the Curonian Lagoon were identified. GIS analysis tools were used to model the data for the period of 2018–2019. Such an approach allowed the obtaining of maps of the spatial distribution of chlorophyll-a concentrations throughout different months and days. In this way, it is easy to distinguish hotspots of cyanobacteria blooms where harvesting would be most effective.

DISTRIBUTION OF CHLOROPHYLL-*a* CONCENTRATIONS IN THE CURONIAN LAGOON BASED ON SENTINEL DATA





Zones of the Curonian Lagoon	2018-09-09, 8:43:56 Chlorophyll-*a*, µg/l				
	Pixels	Min	Max	Mean	SD
1 zone	394	30.16	178.68	76.56	17.23
2 zone	538	36.63	213.41	104.96	38.76
3 zone	528	34.30	280.19	115.67	46.13
4 zone	744	28.98	254.28	119.65	33.96
5 zone	557	26.64	322.04	169.47	67.53
6 zone	1117	25.66	318.63	134.02	81.91

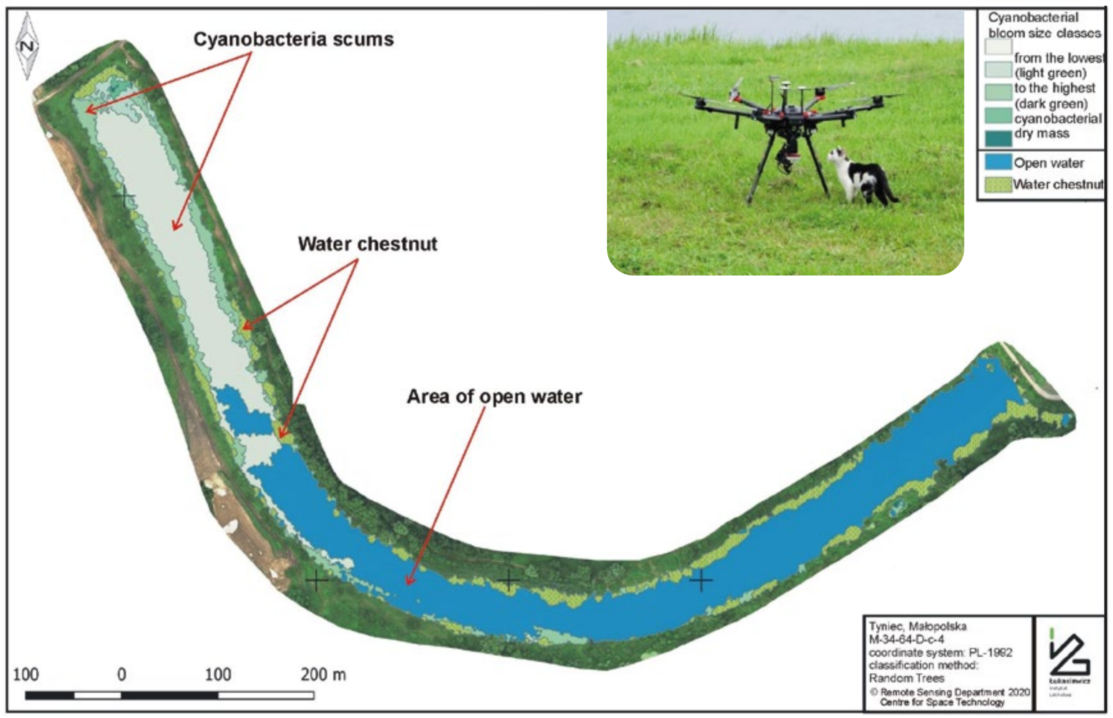
Monitoring of cyanobacteria using low-level aerial imagery from UAV and satellite images in Poland. The methodology for the determination of cyanobacterial biomass in freshwaters using UAV in Poland is under development by the Institute of Nature Conservation, Polish Academy of Sciences in cooperation with the Łukasiewicz Research Network (Institute of Aviation). Photos of selected small water bodies were taken using a UAV Matrice 600 Pro with an integrated multispectral sensor MicaSesne RedEdge-MX.

The following objectives are assessed:

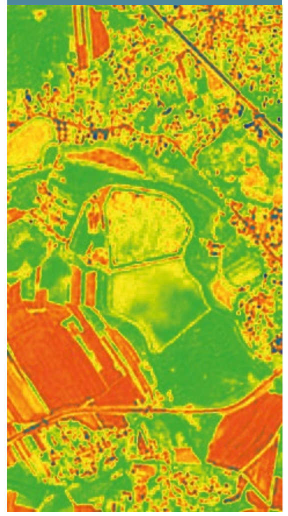
- The proper cyanobacteria and algae biomass in small water bodies;
- The sufficiency of biomass for harvesting;
- The determination of the optimal time of day for biomass harvesting;
- The condition of the aquatic environment in the short and long term after biomass harvesting.

Determining the time of day with the largest surface scums of cyanobacteria allows the harvesting of biomass agglomerations without exposing the ecosystem to losses of any other organisms (fish, amphibians and other animals and plants associated with the ecosystem) or causing disturbance (i.e. collecting biomass only at the surface without disturbing the ecosystem).

VISUALIZATION OF CYANOBACTERIA BLOOM IN TYNIEC CIRCLE OXBOW LAKE (KRAKÓW, POLAND)



SENTINEL IMAGE OF PODKAMYCZE PONDS



16-08-2017

TYNIECKIE CIRCLE OXBOW LAKE AERIAL PHOTO

16-08-2020

Photos taken by UAV on an ongoing basis will be used for the analysis of historical satellite images as it was noticed that it is possible to find a better way for monitoring blooms. Such analyses are more precise and faster than standard methods, and may give much more information. Mapping local reservoirs over the course of a day provides the best time of day to collect the highest amount of biomass. The evaluation of the amount of biomass and the time of its collection are more precise if based on the analysis of UAV images. This is a new way and it is a very promising direction in the analysis of cyanobacteria blooms not used so far in Poland or other countries.

5. How is algal biomass collected in water bodies?

The harvesting of algal biomass in water bodies of different types and sizes requires special technical solutions to ensure the efficient operation of the prototypes. Cyanobacteria scums form relatively thin layer on the surface that is easy to disturb, whereas macroalgae mats form wider stable agglomerations. As a result, the Algae Service-S (AS-S), a specialized prototype harvester, was constructed in 2020 for the collection of macroalgae and cyanobacteria in small water bodies (lakes, rivers). A specialized prototype Algae Service-L (AS-L) for operation in large aquatic ecosystems (lagoons, reservoirs) and harvesting cyanobacteria is under construction.

What is Algae Service-S? → Prototype specialised to collect macroalgae and cyanobacteria → Operates in rivers and lakes

What is Algae Service-L? → Prototype specialised to collect cyanobacteria → Operates in large water bodies (e.g. reservoirs, lagoons)

The prototype harvester Algae Service–S (AS-S) for the collection of algal biomass. The AS-S prototype is a unique device in the market due to its state-of-the-art construction and is designed for the harvesting of algal biomass in small water bodies. The changeable front head allows the operation of two different functions: the collection of macroalgae mats and the collection of cyanobacteria scums. A universal custom made up-down moving conveyor at the front allows the transfer of macroalgal biomass from the bottom and dewaters the macroalgal biomass in a rotating press-container. A specialised newly developed collector for cyanobacteria has a vertical rotating net system that allows the concentrating of scums to dense biomass. The AS-S harvester is environmentally friendly as it has electric engines, batteries and solar panels. After testing the harvester, it was modified to increase the efficiency of harvesting of macroalgal biomass.

Projection

- *500 technical drawings*
- *300 engineering work drawings (dxf files)*
- *Hydraulic calculations*
- *Hydrostatic stability calculations*
- *Electric scheme preparation*
- *Prepared building project*

Manufacturing

- *Selection of required equipment*
- *Selection of required materials*
- *Manufacturing of separate parts: changeable front head, up-down moving conveyor, rotating press container, pontoons, control panel, roof, sides*
- *Installation of eco friendly equipment: electric engines, solar panels*

Receiving of permits

- *Prepared and approved patent*
- *Approved building project*
- *Building supervised by authorities*
- *Registration of AS-S*
- *Registration of AS-S trailer*
- *First and annual technical inspections*

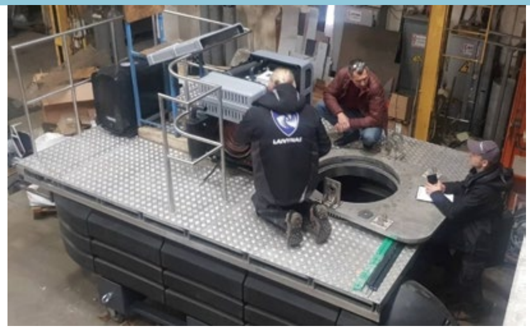
Testings and improvements

- *Up to 100 separate parts testings*
- *More than 10 testings in three different water bodies*
- *More than 20 corrections and improvements on separate parts*
- *More than five different designs*

Exploitation

- *Prepared full safety equipment and manual instructions*
- *Manufactured and tested algae unloading*
- *Macroalgae collection in the River Šventoji*
- *Cyanobacteria collection in Kaunas Reservoir*
- *Use of solar power*

PROCESS OF AS-S HARVESTER CONSTRUCTION



Constructed platform with pontoons

Constructed conveyer

TECHNICAL TESTING

TESTING OF HARVESTING OF MACROALGAL BIOMASS

AS-S PROTOTYPE FOR COLLECTION OF MACROALGAE

AS-S PROTOTYPE FOR COLLECTION OF CYANOBACTERIA

The prototype harvester Algae Service–L (AS-L) for the collection of cyanobacteria scums. The AS-L prototype is designed for the harvesting of cyanobacteria in large surface water bodies and lagoons. The advantage of this prototype is to improve the stability of the treatment equipment in more turbulent water bodies, to increase the amount of collected cyanobacteria from the water by reducing their moisture and volume, to expand the applicability of the harvester and to reduce harmful impact on the environment by using energy from renewable energy sources.

6. What is the amount of algal biomass collected?

Excessive nutrient loading from the catchment area into aquatic ecosystems promotes the formation of large amounts of macroalgal and cyanobacterial biomass. In the tested rivers in Lithuania, the macroalgal biomass varied from 0.6 kg in the River Šventoji to 12 kg wet weight per m² (ww/m²) in the River Jūra. In Poland, the average weight of macroalgal biomass reached up to 6.5 kg ww/m² in Lake Oporzyńskie and up to 6.2 kg ww/m² in the River Nielba.

Overall, 16 tons of macroalgal and 500 kg of cyanobacterial wet biomass were collected from the tested water bodies during 2018-2021. Within the biomass 5.3 kg of phosphorus, 43 kg of nitrogen and 1.63 g of cyanotoxins were removed from the water bodies.

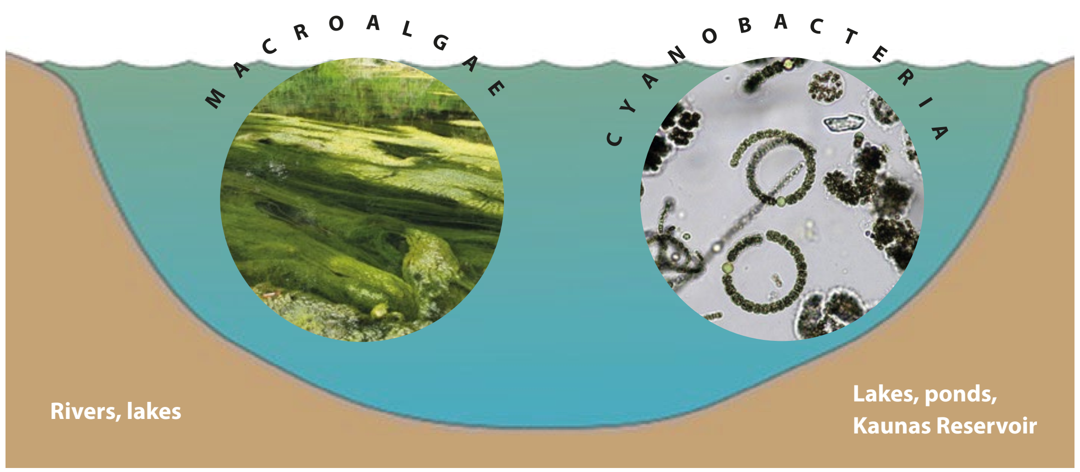
MACROALGAL AND CYANOBACTERIAL BIOMASS REMOVED FROM THE AQUATIC ECOSYSTEMS IN 2018-2021

2.9 t CO_2, 42 kg N, 5.3 kg P

20.6 kg CO_2, 1 kg N, 38.1 g P, 1.6 g cyanotoxins

16 t wet biomass

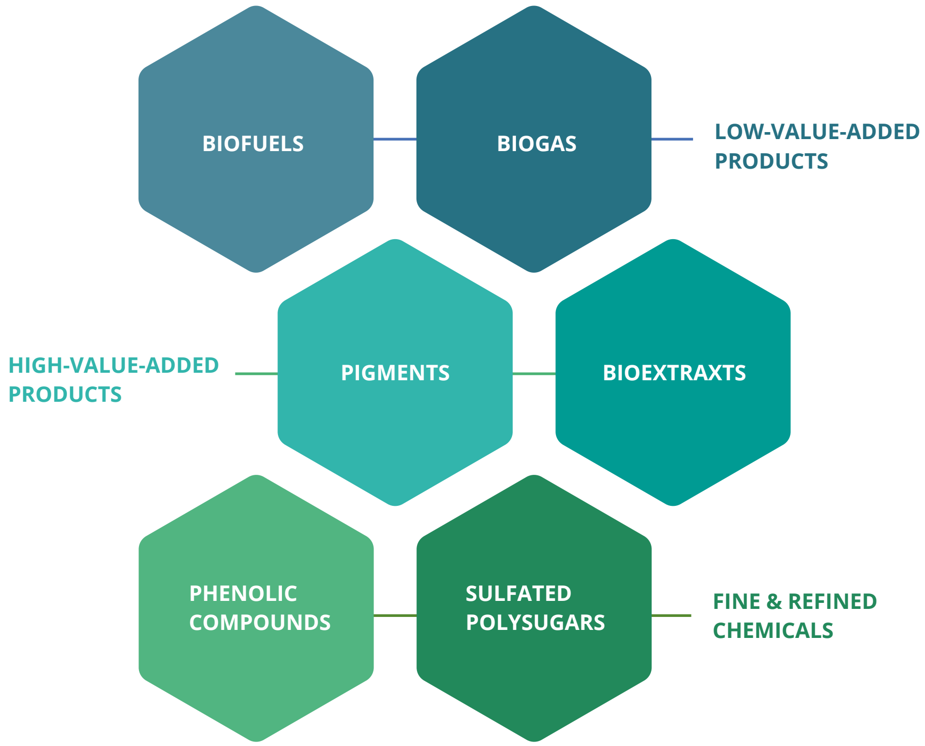
500 kg wet biomass



7. What bioproducts can be produced from algal biomass?

In recent years, algae have received substantially increased interest from the research, industry and policymakers as a potential renewable resource for low value products (biofuel, bioplastics, fertilisers, etc.) and highly valuable compounds (vitamins, ferments, antioxidants, pigments, etc.) for industrial applications. Currently, the high cost of biomass cultivation in different artificial systems is the biggest barrier to its market development, but the harvesting of excess algal biomass from aquatic ecosystems is cheaper and the biomass can be used for various bioproducts.

LOW-VALUE AND HIGH-VALUE ALGAL BIOPRODUCTS



In 2018-2020, 14 tons of macroalgal wet biomass harvested from the selected water bodies were tested for their potential for biogas production, for biofertilizer and for valuable components for cosmetics. About 20 kg of wet cyanobacteria biomass was utilised for extraction of phycocyanin to be used as natural dye.

Algal biomass as slow-release fertilisers. Our samples of harvested macroalgal biomass contained high amounts of nitrogen, phosphorus and potassium (1.5–4.2%, 0.2–0.5% and 3.3–6.0% respectively in dry biomass), this illustrating their suitability for use as an organic slow-release fertiliser. Four groups of plants were selected for the testing of the macroalgal biomass as fertiliser: agricultural crops, horticular plants, flowers and energy horticultural plants.

The testing of the algal biomass as fertilizers included several levels:

- **Lab testing** was performed to test the effect of biomass aqueous extracts on the germination of wheat, barley, peas, cucumber, tomato and basil seeds. Auxin coleoptile tests using dried and decomposed macroalgae biomass were performed to clarify the sprout growth stimulation;
- **Testing in a greenhouse** was carried out to assess the macroalgal biomass effect on the germination and growth of seedlings of agricultural crops and horticultural plants;
- **Field testing on a small scale** was implemented to test the biomass effect on the growth and yield of agricultural crops. Corn and barley were grown throughout the growing season in various size (0.25 m² and 4 m²) experimental fields that were enriched in dried, frozen, composted and decomposed macroalgal biomass and chemical fertilisers;
- **Field testing on a large scale** was implemented to test the biomass effect on the growth and yield of potatoes and barley in agricultural fields (6 different testing sets) using macroalgal biomass collected from Lake Oporzyńskie. The macroalgal biomass increased the yield of barley and potatoes more efficiently than organic manure or mineral fertilizer during the first field testing.

MACROALGAL BIOMASS TESTING AS FERTILIZER

TESTING IN LABORATORY AND GREENHOUSE

Basil

Peas

TESTING IN EXPERIMENTAL FIELDS

Barley

Corn

TESTING IN AGRICULTURAL FIELDS

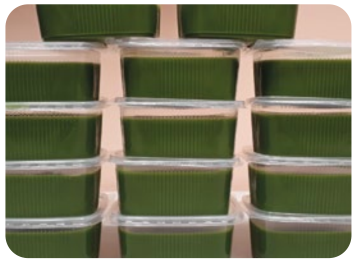
Potatoes

Barley

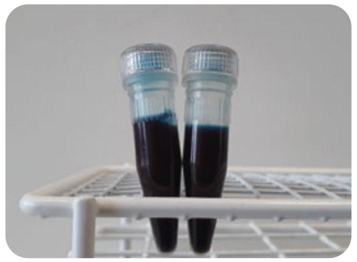
Biogas production from algal biomass. Macroalgal biomass harvested from the River Nevėžis was mixed with manure at a proportion 50:50 and was uploaded as substrate for biogas production. The substrate ratio and composition will be assessed in order to increase the efficiency of biogas production.

Biomass refining: preparation and analysis of value-added products. Harvested cyanobacteria biomass from the tested water bodies was used for phycocyanin extraction and for method optimization. Phycocyanin was successfully extracted from cyanobacterial biomass with dominant *Aphanizomenon flos–aquae*. The purity and stability of the pigment were also tested.

PHYCOCYANIN EXTRACTION FROM CYANOBACTERIA BIOMASS



Harvested and frozen biomass

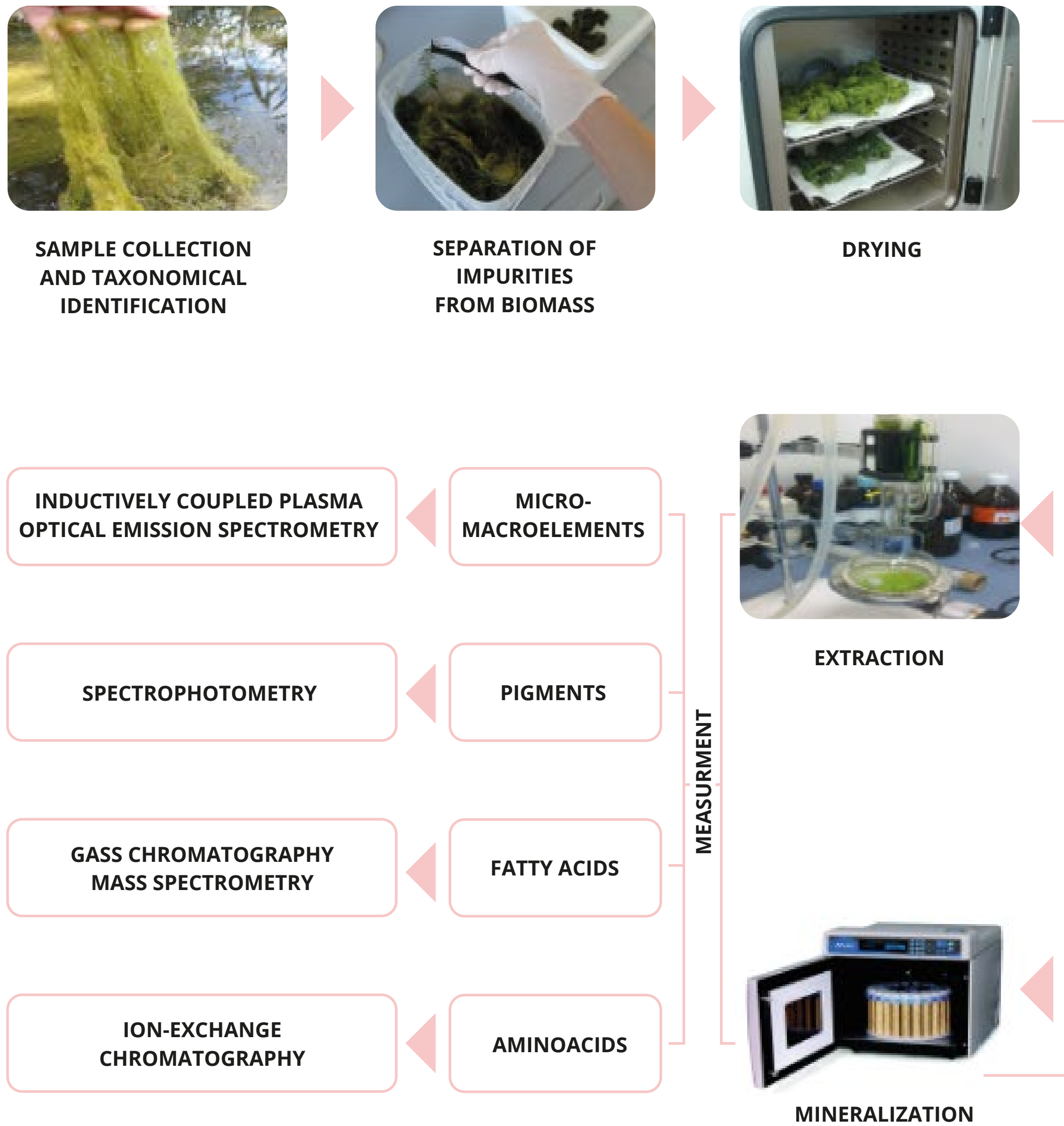


Purified phycocyanin

Freeze-dried phycocyanin

For biomass application in the field of cosmetics various bioactive metabolites (polyphenols, fatty acid, polysaccharides, carotenoids, amino acids, etc.) of macroalgae species (*Cladophora glomerata, Ulva flexuosa*) were tested. For the creation of commercial products, preparation of algae extracts was done using different extractions methods: microwave-assisted, ultrasonically-assisted, Soxhlet.

BIOMASS REFINING: PREPARATION AND ANALYSIS OF VALUE-ADDED PRODUCTS



CREAM PREPARATION

APPLICATION STUDY

RESULTS

TESTED ALGAL EXTRACT-CONTAINING CREAMS:	• Base cream without algal extract • Cream with algal extract (concentration of 0.5%) • Cream with algal extract (concentration of 2%)

TEST PARAMETERS:	• Research time: five-week period • Probants – two research groups: I. People 20-40 years of age II. People over 40 years of age • Skin properties tested: moisture and elasticity

Various groups of biologically active metabolites with unique multidirectional properties were found and *in vitro* tests on the antioxidant properties of the extracts were carried out. A number of the detected bioactive compounds in the macroalgal extracts had antioxidant, moisturizing and elasticizing properties that open prospects for the use of algae as a new effective raw material for cosmetic emulsions, primarily for moisturizing, nourishing, anti-aging or anti-wrinkle creams, cosmetic masks, shampoos and hair conditioners and even body lotions for sun protection.

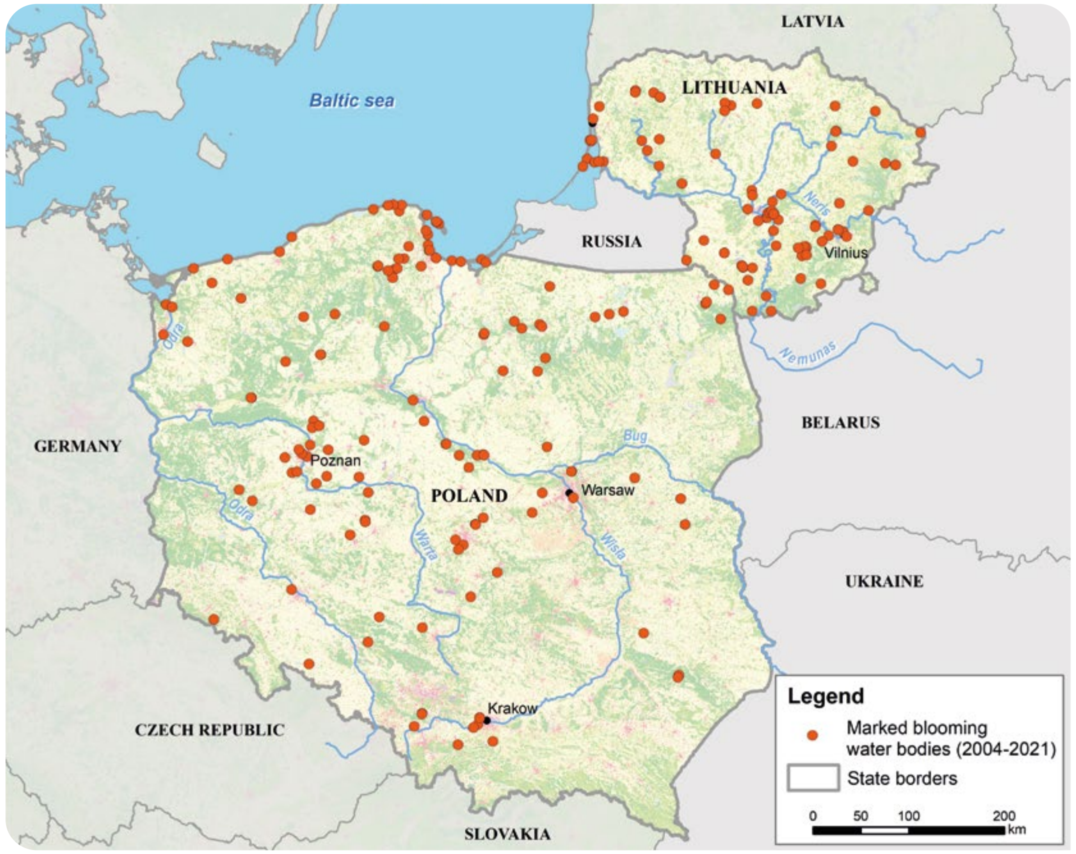
Where can you find more information about the project?

8.

Containing all the information about the project, the obtained results and other relevant news, the **project website** (*https://algaeservice.gamtostyrimai.lt/*) is updated regularly with the information regarding recent events and those upcoming.

The mobile ArcGIS application "Mark a Blooming Water Body" (*https://arcg.is/0jqvCn*) is designed to mark the locations of blooming water bodies. The information gathered is used for data analysis according to the distribution of the locations of blooming water bodies.

In parallel, an **interactive map** (*https://arcg.is/1v5faT*) of the distribution of blooming water bodies together with their photos is also available. This helps to further promote the ArcGIS application, to control the quality of the gathered data and to define the water basins where measures to decrease the nutrient load have to be applied first. This will allow the planning of the continuation of activities after the LIFE project.



A **questionnaire** "Water Blooms" (*https://bit.ly/2LnUa9J*) has been created in three languages (LT/PL/EN) to conduct a study on knowledge about water blooms.

For the easier access of the project website, mobile application, interactive map and questionnaires **Quick Response (QR)** codes were created and are available on all printed materials (leaflets, notice boards, etc.).

PROJECT WEBSITE

MOBILE APPLICATION

INTERACTIVE MAP

QUESTIONNAIRE

Furthermore, accounts and profiles of the project exist on social networks (Facebook, YouTube channel and ResearchGate) and serve as an additional communication tool for reaching the wider public and scientific community:

- „Facebook" - *https://bit.ly/3hfbmhp*
- „YouTube" - *https://bit.ly/3hjPUaO*
- „ResearchGate" - *https://bit.ly/3A9TcpN*

Popular papers have also been published in news portals, newspapers and journals. The aims of these popular papers were not only to acquaint the public with the problems and dangers of algal blooms in water bodies, but also to promote the ongoing project. Interviews in news portals (www.lrytas.lt and www.lrt.lt) have been published as well.

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