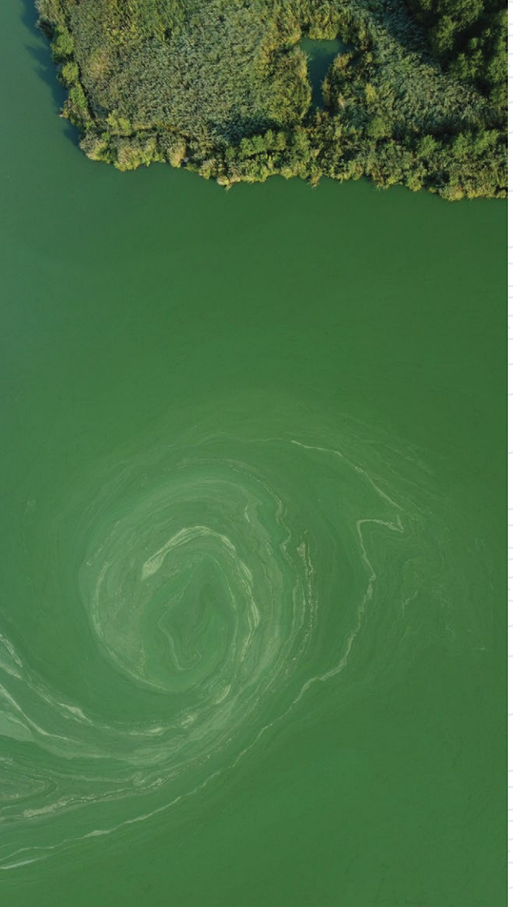


COORDINATING BENEFICIARY

ASSOCIATED BENEFICIARIES

PROJECT IS FINANCED BY



Algae Service for Life

# LAYMAN'S REPORT

## ALGAE – ECONOMY BASED ECOLOGICAL SERVICE OF AQUATIC ECOSYSTEMS

LIFE17 ENV/LT/000407

# The goal of the project

is to promote best practices in ecological services and the circular economy approach by implementing an innovative complex system.



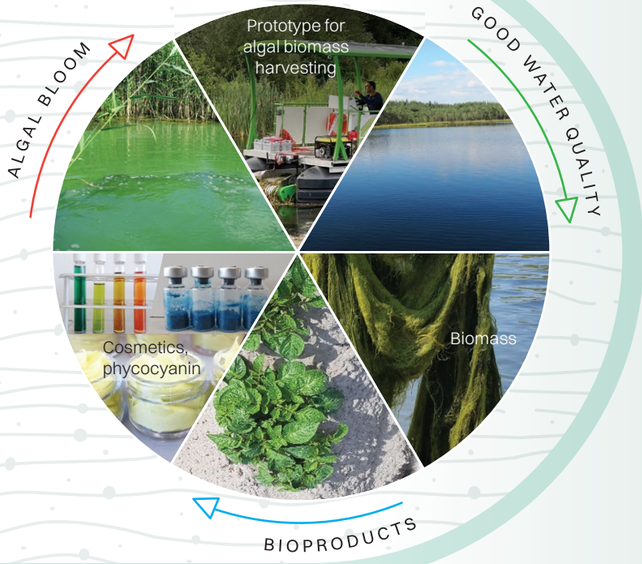
## The problem

Aquatic ecosystems exposed to accelerated nitrogen and phosphorus loading experience eutrophication, leading to uncontrolled growth of macroalgae and cyanobacteria.

### Macroalgal agglomerations and cyanobacteria blooms:

- negatively affect water quality, reduce biodiversity and heterogeneity of biotopes
- the decomposition of algal biomass causes oxygen depletion, promotes nutrient enrichment and triggers an unpleasant smell
- cyanobacterial toxins pose a health risk that can lead to the death of humans, wildlife, and livestock
- cause significant economic losses to water-related activities (tourism, fisheries, etc.).

## Circular economy approach of the project




## Objectives

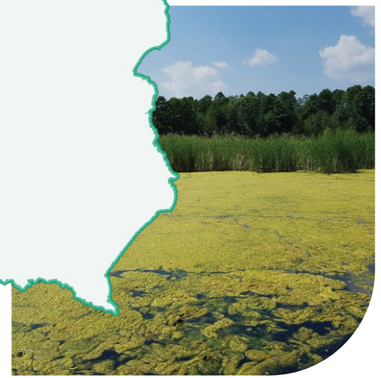
- To demonstrate integrated efficient management of nutrients and algal blooms through the harvesting of macroalgae mats and cyanobacteria scums.
- To test and demonstrate the redesigning of harvested biomass into potentially valuable products.
- To raise awareness to environmental, water quality and health hazard issues.

Nielba

Tynieckie

## Poland

- 6 lakes
- 2 ponds
- 2 rivers



Oporzynskie

Podkamyczie

Legowskie

Tynieckie



Nevėžis

Simnas fish ponds

Šventoji

## Lithuania

- Curonian Lagoon
- Kaunas Reservoir
- Simnas fish ponds
- 3 lakes
- 4 rivers

Jūra

Simnas

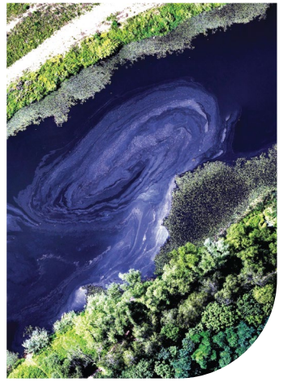
Kaunas Reservoir

# Assessment of algal agglomerations using images from unmanned aerial vehicles and satellites

Remote sensing methods served as an innovative tool for monitoring blooms in inland water bodies and identifying hot spots with algal biomass agglomerations.

## Advantages

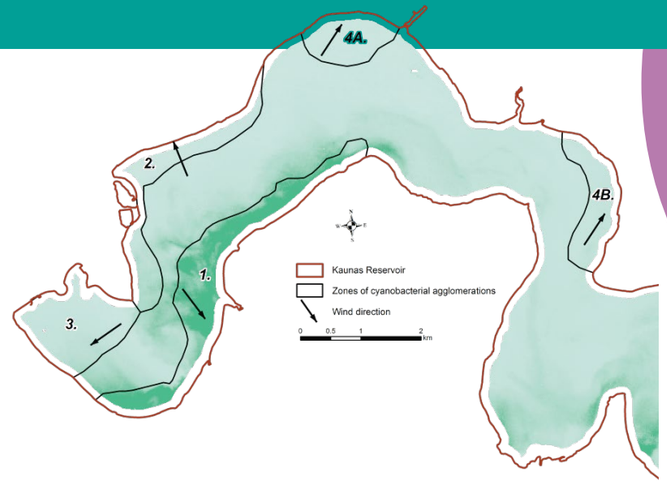
- Faster than conventional monitoring of macroalgal and cyanobacterial agglomerations
- Provides an approximate estimate of macroalgae and cyanobacteria biomass
- Can be used to increase efficiency in harvesting algal biomass by determining hot spots of agglomerations
- More cost-effective survey compared to traditional *in situ* monitoring



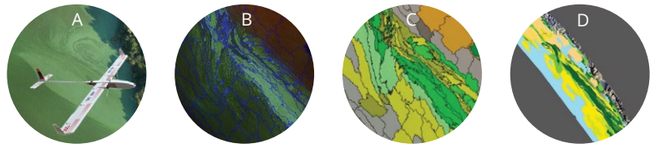
***Tynieckie Circle oxbow lake*** was used as a model reservoir for analyses two types of photos: UAV and satellite images for developing of the new tool for cyanobacteria scums monitoring, based on blue pigments characteristic. Based on satellite scenes downloaded from the Sentinel Hub, an animation of NDVI indicator scenes was created as an example to visualize vegetation changes over the season of the year.

## Calculation of the accumulated biomass

- During a bloom in the Kaunas Reservoir, up to 33 278 tons of cyanobacterial biomass can be accumulated in an area of 1 km² near the shore. In the areas with concentrated biomass (0.286 km²), up to 578 t of cyanobacteria with an average density of 20-28 kg/m² can be accumulated.
- In total, 10 776 t of macroalgae biomass can be accumulated in the 140 km long river sections. The amount of biomass can vary between 40 and 904 t per river kilometer.




**Stages of orthophoto analysis:** A – taking aerial photographs with a fixed-wing UAV; B – segmentation of aerial photographs; C – classification of designated areas; D – determination of concentration and accounting.




## Limitations

- Assessment requires advanced techniques and a high level of expertise for image analysis

*For the assessment of macroalgae*

- Clouds, solar radiation, water transparency, shadows from trees and shoreline
- Similarity of macroalgae to some aquatic macrophytes

*For the assessment of cyanobacteria*

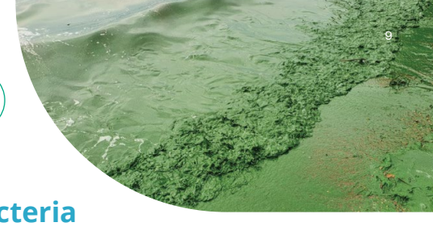
- Wind mixing, surface layer instability, thickness of scum layer

- SENTINEL satellite images are suitable for determination of distribution of concentrations of chlorophyll-*a* for large water ecosystems.
- Satellite data and GIS tools allow to select proper water bodies in the manner of not only identification of hot-spots of cyanobacteria scums, but also provide crucial temporal and spatial information for collection of such biomass.

# Manufactured prototypes

| Characteristics | AS-S | AS-L | AS-LAND |
|---|---|---|---|
| Target biomass | Macroalgae, cyanobacteria | Cyanobacteria | Cyanobacterial scums near shore |
| Type of water | Rivers, lakes and ponds | Large lakes, reservoirs, lagoons | Lakes, ponds, littoral zone |
| Mobility | Towing a car (SUV) on a trailer | Special trailer with manipulator | Easily transportable on trailer |
| Size and other specifities | Length - 4 m, width - 2.45 m, height - 2.2 m, weight - 1.5 t | Length - 9 m, max width - 4.8 m, height - 3.8 m, weight - 4 t | Two parts:<br>Floating collecting device: 1.3×1.7 m<br>Concentrating on-land device: 4.6×1 m² |
| Area of filtration mesh | For cyanobacteria - 3.38 m² | 13.52 m² | 4 m² |
| Filtration rate of water | For cyanobacteria - 1.07 m³/h | 4.27 m³/h | 1.2-10.9 m³/h (depends on the concentration in water body) |
| Efficiency | Up to 2000 kg/h wet macroalgae biomass<br>30-80 l/h wet weight of cyanobacteria | 120-350 l/h wet weight | Up to 136 kg/h wet weight |
| Biomass density | Up to 4% dry weight of cyanobacteria | Up to 4% dry weight | Up to 5.8 (average 4.8) % of dry weight |
| Collected amount of wet biomass | 60 t wet weight of macroalgae<br>1 t wet weight of cyanobacteria | 8 t wet weight | 4.14 t wet weight |
| Other | Fully electrical, renewable energy, gentle collection, lightweight, transformer.<br>Patend No 6681. | Trimaran, biomass storage tank inside, renewable energy, non-chemical biomass collection, gentle collection in column.<br>Patent No 6844. | Under patenting |

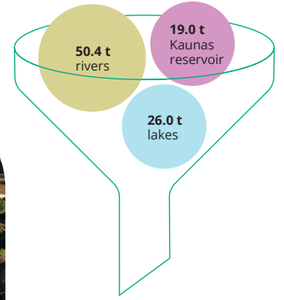




## Algal biomass collected

### Macroalgae

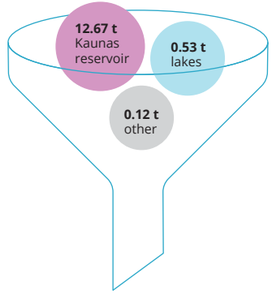
biomass was harvested from 2 lakes, 4 rivers and Kaunas reservoir




95.4 TONS

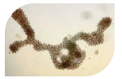
### Cyanobacteria

biomass was gathered from 4 lakes, 1 pond, Kaunas reservoir and Simnas fish pond




13.3 TONS

Eliminating biomass removes nutrients, carbon and cyanotoxins from waterbodies.



*Eliminated:*

**P – 34.1 kg** **N – 362.2 kg** **$CO_2$ – 20.5 t**

*Eliminated:*

**Cyanotoxins – 0.37 kg**

## Low value products

## FERTILIZERS

Macroalgal biomass as an organic slow-release fertilizers was tested.

**Corg.** 13.1-72.8%

**K** 1.2-8.3%

**N** 1.5-4.5%

**P** 0.1-0.5%

Chemical composition of *Cladophora glomerata* (% in dry biomass).

Laboratory

Macroalgal aqueous extracts (5% and 25% concentration) had a positive effect on germination of tomatoes, basil, spring wheat and cucumber seeds. The extracts have no effect or even negative for peas seeds.

Experimental fields

Variously prepared macroalgal biomass, applicated into light-textured soil as a fertilizer, increased the yield of cereals and storage plants by 47-104%. The application of biomass for fertilization in spring was 50% more effective.

Agricultural fields

Fertilizer obtained by adding macroalgae biomass to manure was highly successful in enhancing potatoe crops yields, up to around 80% compared to control.

## BIOGAS

- 35.6 t of macroalgae and 9 t of cyanobacteria wet biomass were used for biogas production.
- 832 m³ of biogas was produced.
- 4 925 kWh of energy was produced with a methane concentration of 65-75% and a yield of 0.58-0.80 m³/d/m³ of substrate.

The installed photobiofilter for biogas upgrading:

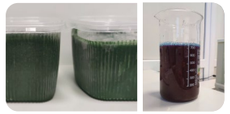
- increase of methane concentration by 5-8%
- reduse $CO_2$ by 8-15% and $H_2S$ by 12-40%.



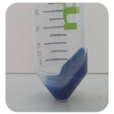
## High value products

## PHYCOCIANIN

Was extracted and purified from wild non-toxic cyanobacteria biomass collected from the Kaunas reservoir.



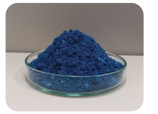
Phycocianin extraction from cyanobacteria



Precipitation with amonium sulfate

Ultrafiltration and purification using gel filtration or ion exchange chromatography

Freeze drying (lyophylization)



Freeze-dryed phycocyanin powder

The method for extraction and purification of phycocyanin was optimised. Phycocyanin purity varied from food grade used for food and cosmetic to analytic grade.

## MACROALGAE EXTRACTS

**STEP BY STEP | From raw macroalgae to high value cosmetic products:**

Macroalgae raw material is first cleaned, de-encrusted and crushed before extraction

Solvent extraction, followed by low-pressure evaporation isolates the active compounds

A suitable emulsion base is developed, which will complement the macroalgae extract

The final cosmetic product undergoes stability, purity and consumer-based testing

# Benefits for environment and society

**Reduction of eutrophication leads to:**

- better water quality
- improved air
- healthier soil
- better conditions for animal and plant habitats
- more attractive living and recreation conditions for citizens and a possibility to augment economic activities.

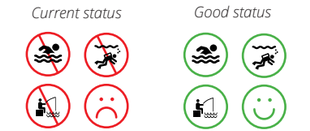
**Successful production of bioproducts using the extracted biomass brings:**

- new market opportunities
- greater employment
- increased profits, etc.

All these types of benefits together provide economic benefits, which we captured in our analysis.

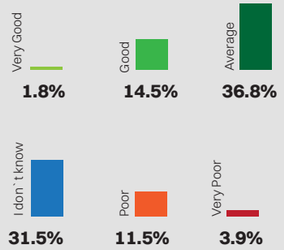
- A large proportion of the respondents are ready to pay for the improvement of its quality. 67% of respondents indicated their strong or possible wish to pay for reaching good status of the Kaunas Reservoir.
- Achievement of all those benefits in the Kaunas Reservoiris valued up to 10 Eur/person/year on average in Lithuania. Aggregated benefit would amount to approx. Eur 24 mln. / year in Lithuania and, assuming the WTP for achieving good water body status per person in Poland is the same, Eur 280 mln. / year in Poland.

One of good tools to monetise benefits - Willingness to Pay surveys. We implemented one in Lithuania for the Kaunas Reservoir to assess the change of its water quality from current to good status.

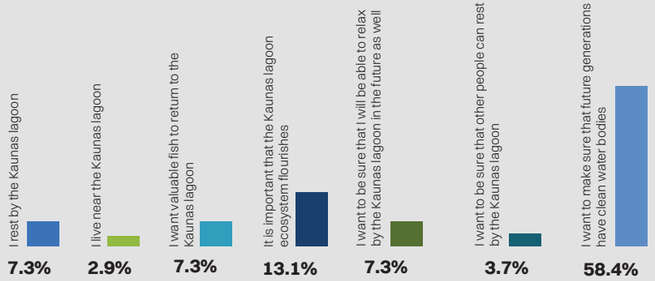



**52%**

of respondents from a representative sample admit that the Kaunas Reservoir water quality can best be described as **average, poor or very poor:**




**Reasons why people are willing to pay**
for the improvement of the water quality:






## Networking and transferability

Project **„ECO-AQUA-RECYCLE“**

Łukasiewicz Institute of Aviation

Southern Region (Simnas) Pisciculture Division

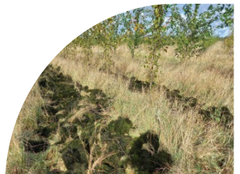
NutriBiomass 4LiFE

KLAIPĖDA UNIVERSITY

COASTAL BIOGAS

LITHUANIAN UNIVERSITY OF HEALTH SCIENCES

Medical and Veterinary Academies



## Dissemination

| | |
|---|---|
| Popular papers **>20** | Interview to media **>20** |
| **Communication events with:** | Scientific conferences **>25** |
| Society **>25** | Research articles **4** |
| Key stakeholders **>15** | Project proposals **8** |
| Scientific community **>10** | Networking **14** |

SCAN OR CLICK

Watch our project video

SCAN OR CLICK

**Follow the project at**
*https://algaeservice.gamtostyrimai.lt*



## Training seminars and demonstration events

Total number of participants:

live **277**

online **160**

SCAN OR CLICK

Anykščiai – harvesting of macroalgae by AS-S

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Krakow - harvesting of cyanobacteria by AS-S

SCAN OR CLICK

Poznan - harvesting of cyanobacteria by AS-S

SCAN OR CLICK

Vilnius – remote sensing methods

SCAN OR CLICK

Kaunas - harvesting of cyanobacteria by AS-L