(Projects funded under the Call 2014 onwards must use this format)

LIFE Project Number

LIFE17 ENV/LT/000407

Final Report

Covering the project activities from 01/08/2018 to 30/11/2023

Reporting Date

30/11/2024

LIFE PROJECT NAME or Acronym

AlgaeService for LIFE

Data Project

Project location:	Lithuania, Greater Poland Voivodeship and Lesser Poland Voivodeship
Project start date:	01/08/2018
Project end date:	31/07/2023 **Extension date:** 30/11/2023
Total budget:	3 674 830 €
EU contribution:	2 193 710 €
(%) of eligible costs:	59.70

Data Beneficiary

Name Beneficiary:	Nature Research Centre
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Project Website:	https://algaeservice.gamtostyrimai.lt/

Executive Summary

PROJECT OBJECTIVES AND KEY RESULTS

The final project report describes the project results in accordance with the project objectives, summarises the results of the individual measures and addresses the political impact and sustainability. The project aims to promote best practices in ecological service and the circular economics approach by implementing innovative complex system which has demonstration and innovation character. The project has three objectives: i) to demonstrate integrated efficient management of nutrients and algal nuisance blooms by harvesting of cyanobacteria scums and macroalgae mats; ii) to test and demonstrate the redesigning of waste biomass of cyanobacteria and macroalgae into potential valuable products; iii) to raise awareness to environmental, water quality and health hazard issues among the national governments, local authorities, the business community and society.

As part of Actions A1 and B1, three prototypes of different types and sizes for harvesting algae biomass were produced, tested and demonstrated. The technologies are patented at the State Patent Bureau of the Republic of Lithuania (Fig.1). AS-S prototype is mainly designed for the collection of macroalgae (up to 2 t/h), but can also be modified for the collection of cyanobacteria and floating macrophytes (Fig. 2). AS-L prototype is designed for the collection of cyanobacteria scum in large water bodies with a biomass collection rate of 120–350 l/h (Fig. 3). The AS-LAND consists of a floating collector and a concentrator on land and collects up to 136 kg/h of wet cyanobacteria biomass in small water bodies or near-shore accumulations (Fig. 3). In total, more than 95 t of macroalgae and 13 t of cyanobacteria biomass were collected per project. Together with the biomass, 34 kg of phosphorus, 362 kg of nitrogen, 20.5 t of CO2 and 0.37 kg of cyanotoxins were removed from the aquatic ecosystems. Four demonstration events with the harvesters were organized in Lithuania and Poland.

LIETUVOS TRANSPORTO SAUGOS ADMINISTRACIJA
LITHUANIAN TRANSPORT SAFETY ADMINISTRATION
VIDAUS VANDENŲ TRANSPORTO PRIEMONĖS REGISTRACIJOS LIUDIJIMAS
CERTIFICATE OF INLAND WATERCRAFT REGISTRATION

2020-06-11
Kaunas

Registro Nr. **LT-PI-756**
Laivo pavadinimas – **AS-S**
Laivo tipas – **plūduriuojantis įrenginys**
Laivo paskirtis – **paviršinių vandens telkinių valymas**
Laivo modelis – **b/p**
Unikalus identifikavimo kodas – **0000366499**
Statybos metai – **2020**
Kilmės šalis – **Lietuva**
Korpuso Nr. **AS-S-2020**
Korpuso medžiaga – **aliuminis**
Korpuso spalva – **pilka**
Maksimalus ilgis – **7,69 m**, plotis – **2,45 m**

LIETUVOS RESPUBLIKOS VALSTYBINIS PATENTŲ BIURAS
STATE PATENT BUREAU OF THE REPUBLIC OF LITHUANIA

PATENTAS
Patent
Nr. 6681

It is hereby certified that following the Patent Law of the Republic of Lithuania the invention as outlined in the attached Patent Specification has been entered into the Register of Patents of the Republic of Lithuania.

Išdavimo data / Date of issue 2019-11-25, Vilnius

Direktorė / Director

LIETUVOS TRANSPORTO SAUGOS ADMINISTRACIJA
LITHUANIAN TRANSPORT SAFETY ADMINISTRATION
VIDAUS VANDENŲ TRANSPORTO PRIEMONĖS REGISTRACIJOS LIUDIJIMAS
CERTIFICATE OF INLAND WATERCRAFT REGISTRATION

2022-07-07
Klaipėda

Registro Nr. **LT-PI-767**
Laivo pavadinimas – **ALGAE SERVICE L**
Laivo tipas – **vandens telkinių valymo įrenginys**
Laivo paskirtis – **telkinių valymas nuo dumblių**
Laivo modelis – **b/p**
Unikalus identifikavimo kodas – **0000369532**
Statybos metai – **2022**
Kilmės šalis – **Lietuva**
Korpuso Nr. **BM061C021**
Korpuso medžiaga – **aliuminio lydinys**
Korpuso spalva – **pilka-balta**
Maksimalus ilgis – **11,20 m**, plotis – **5,80 m**

LIETUVOS RESPUBLIKOS VALSTYBINIS PATENTŲ BIURAS
STATE PATENT BUREAU OF THE REPUBLIC OF LITHUANIA

PATENTAS
Patent
Nr. 6844

Fig. 1. Registration documents and patents of AS-S and AS-L prototypes.

Fig. 2. AS-S prototype prepared for the collection of macroalgae mats (left) and cyanobacteria scums (right).

Fig. 3. Cyanobacteria biomass harvesting prototypes: AS-L (left) and AS-LAND (right)

In the frame of Action B2, the methodology for the assessment of macroalgae and cyanobacteria agglomerations in inland aquatic ecosystems by remote sensing was prepared and validated (Fig. 4). A guide for monitoring aquatic blooms and mitigating eutrophication of inland water bodies based on remote methods and *in-situ* analysis was prepared. Analysis of Sentinel satellite images allowed to select water bodies more suitable for harvesting. Analysis of UAV imagery revealed that macroalgae can cover more than 270 ha of area in 140 km of waterways tested with a total calculated amount of over 10776 tonnes (density 40–904 t/km in different river sections). Analysis of UAV images revealed a total over 33000 t of accumulated cyanobacteria biomass in 1 km^2 of littoral zone in Kaunas Reservoir. The concentrated cyanobacterial assemblages covered an area of 0.286 km^2 and the total amount of harvestable biomass was 578 tonnes, with densities varying between 20 and 28 kg/m^2.

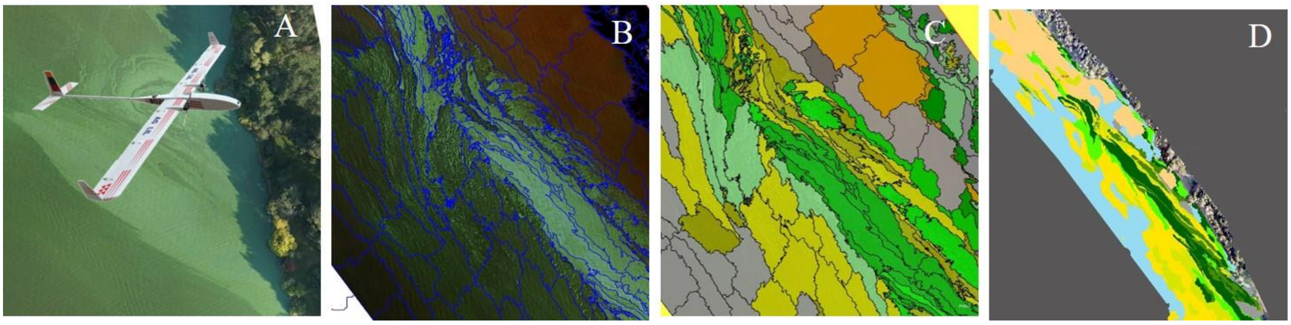
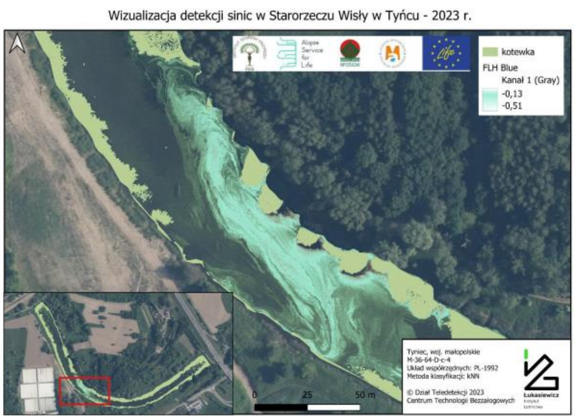


Fig. 4. Steps of orthophoto analysis: A – taking photographs with a fixed-wing UAV; B – segmentation; C – classification of designated areas; D – determination of concentration and accounting.



A Polish partner, in collaboration with the Łukasiewicz Institute of Aviation in Warsaw, has also carried out remote monitoring of cyanobacterial blooms using UAV and Sentinel-2 satellite imagery and demonstrated its usefulness for monitoring cyanobacteria and algal blooms (Fig. 5).

Fig. 5. Cyanobacteria detection map based on FLH Blue indicator.

As part of Action B3, the collected biomass of cyanobacteria and macroalgae was tested for biogas, biofertilizer and high-value bioproducts (Fig. 6). A total of 832 m^3 of biogas (4925 kWh of energy) was produced from 35.6 t of macroalgae and 9 t of cyanobacteria as wet biomass. The methane concentration reached 65–75% and a yield of 0.58–0.80 $m^3/d/m^3$ substrate. The installed photobiofilter for biogas upgrading led to an increase of methane concentration by 5–8% and a reduction of CO_2 by 8–15% and H_2S by 12–40%.

Fig. 6. System for biogas production: images from the left photobiofilter for biogas upgrading, digestate and biogas tank, bioreactor, biomass shredder, control panel and generator.

Macroalgae biomass applied to the soil has the same fertilizing effect on plant productivity as conventional organic fertilizer and increases the yield of cereals and storage crops by 47–104%. High nutrient contents were found in the *Cladophora* biomass (on average 3.0% N, 0.3% P, 4.8% K and 54.4% organic matter). Mobile phosphorus and potassium increased in the soil up to 60 mg/kg. The yield of potatoes increased by up to 83% and their starch content by up to 21% when grown in soil enriched with algae, which enabled the granting of a patent by the Patent Office in Poland.

The method for extracting and purifying phycocyanin from the biomass of wild cyanobacteria was optimized (Fig. 7). Pigment quality ranging from food to analytical grade was obtained from non-toxic wild cyanobacteria biomass and tested as a component of feed additives in the EUREKA transfer project „Eco-Aqua-Recycle”. Formulations of three products with the *Cladophora* extract (cream, peeling butter and shampoo) were prepared (Fig. 7). The positive effect of the extract on skin elasticity and on the stability of the cosmetic emulsion was confirmed. Both high-value products (phycocyanin and extracts for cosmetics) have been developed to certification stage, which requires a longer period for testing in independent laboratories with GMP certification.

Fig. 7. Phycocyanin extraction and purification from cyanobacteria biomass harvested in aquatic ecosystems (left) and developed cosmetic products with *Cladophora* extracts (right).

Action C1. Slight improvement in water quality compared to baseline was observed in some water bodies, but harvesting should take place over a much longer period to achieve an improvement. The modelling applied to Lake Simnas ecosystem has shown that only a reduction in nutrient input from the catchment will improve water quality and that harvesting cyanobacteria and macrophytes alone is not sufficient. The socio-economic assessment of biomass removal was carried out by comparing the annual costs for the development and operation of prototypes with the calculated annual benefits for the most important ecosystem services and employment. The project measures implemented show a positive benefit-cost result, which speaks in favour of replicating these measures. Up-scaling the biomass harvesting would deliver more efficient results in agriculture and biogas production. Processing macroalgae as fertilizer has a positive impact on reducing eutrophication of freshwater (+482%) and the marine environment and has a strong impact on human carcinogenicity as cyanotoxins are removed.

In Actions D1 and D2, awareness-raising and dissemination of the project results as well as efforts for replication and transfer at national and international level were actively implemented. All communication indicators defined in the plan were achieved and exceeded. The "Water Blooms" questionnaire and the ArGIS application were developed as a tool to engage the wider public. 2204 people completed the questionnaire and marked algal blooms in water bodies. 8887 participants attended 18 community events. 25 popular publications, 24 interviews on various broadcast channels were published, 10 videos (including the project video) were produced. In total, more than 17000 readers/views were reached. Eleven project proposals, linked in one way or another to the LIFE project, were submitted in order to replicate and transfer the project results.

Within the Action E1, Partnership agreements were signed between the partners at the beginning of the project. Three progress reports, the mid-term report and all deliverables were submitted to EASME. Project progress and issues were discussed with the partners in 22 progress meetings and in over 30 bilateral meetings. Information on project progress and requested documents was provided to EASME during the annual meetings with the monitoring expert and the project advisors. The amendment to the Grant Agreement to extend the project duration by 4 months and to produce the third prototype was signed.