LIFE17 ENV/LT/000407

Algae Service for Life

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Executive summary of recommendations, related with the project results, for policy makers and business

ALGAE – ECONOMY BASED ECOLOGICAL SERVICE OF AQUATIC ECOSYSTEMS
(AlgaeService for LIFE; No LIFE17 ENV/LT/000407)

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RECOMMENDATIONS FOR THE MANAGEMENT OF ECOSYSTEMS AND WATER QUALITY

Determining the source of pollution in rivers. In flowing waters, it is difficult to determine the source of pollution as the pollutants released are displaced downstream. However, *Cladophora* macroalgae are a perfect indicator for nutrients loading, as they actively take up the released nutrients and accumulate them in their biomass. The formation of their agglomerations can therefore serve as an indicator that the source of the nutrient release upstream is in close proximity. Inspectors should carefully check whether there are possible point polluters (fish farms, sewage treatment plants, homesteads illegally discharging wastewater into the river) or diffuse sources (narrow buffer zones near agricultural fields).

Harvesting algal biomass (both cyanobacteria and macroalgae) is an environmentally friendly solution to combat eutrophication. The harvesting is most suitable for small aquatic ecosystems with limited water turnover, but can also be part of complex solutions that contribute to the restoration of large aquatic ecosystems by removing part of the biomass from the life cycle, enabling greater biodiversity and better living conditions, and facilitating the process of ecosystem self-restoration. Of particular importance is the removal of accumulations of toxic cyanobacteria biomass at bathing sites or places of intense recreational activity, which helps to significantly reduce the risk associated with poisoning and achieve a positive social perception.

Remote sensing is suitable for monitoring of algal blooms and the assessment of cyanobacteria scums and macroalgae agglomerations in ecosystems heavily affected by eutrophication. Satellite and UAV imagery are remote sensing methods with varying sensitivity and resolution that predetermine their application for monitoring inland aquatic ecosystems. Satellite imagery is useful for distinguishing between large aquatic ecosystems where an intense surface bloom occurs and those where the blooming species are distributed in the water column, but it has a limitation in nearshore areas where a dense agglomeration of biomass usually forms, in small water bodies and in rivers, for which the UAV assessment is more suitable. The UAV method also provides an approximate assessment of accumulated algal biomass, but needs to be adjusted on a case-by-case basis to increase accuracy.

Management of eutrophication. The choice of the right measures for a particular water body to improve water quality must be assessed on a case-by-case basis, and the modelling tool applied to the functioning of the ecosystem can be very helpful, as in the case of Lake Simnas. Two water quality improvement measures were carried out in the lake: the removal of cyanobacteria scums as part of the "AlgaeService for LIFE" project and the removal of macrophytes in the littoral zone as part of the activities carried out by the municipality. The detailed assessment of the physico-chemical and biological variables in the lake revealed that the harvesting of cyanobacteria is only possible during one week in the season, as most cyanobacteria do not form scums but are mixed into the water column by the wind. The modelling based on the collected data showed that neither of the two proposed methods can contribute to the reduction of eutrophication of such a large water body and only reduction in nutrient loading from the catchment by 40% can bring a real result. The right measures are currently being implemented, in particular: i) the reconstruction of the Simnas village wastewater treatment plant and ii) the new LIFE project "Integrated water management in Lithuania" LIFE22-IPE-LT-LIFE SIP "Vanduo" (2024–2034), which will create the conditions for restoring the good status of water bodies in the Dovinė River basin, including measures to reduce pollution from agriculture and modernise the Simnas fish farm.

RECOMMENDATION TO LEGISLATION IMPROVEMENT

Monitoring risks in bathing areas. The hygiene legislation has been amended according to the suggestions and currently include monitoring of Secchi depth or chlorophyll-a or phytoplankton analysis depending on the water quality at the bathing site. However, the system could be further simplified to save cost and time for analysis. Phytoplankton analysis is recommended when Secchi depth and chlorophyll-a values exceed safe limits and phytoplankton analysis is required. When assessing the risk of cyanotoxin poisoning, phytoplankton analysis could include only the cyanobacteria specifically responsible for cyanotoxin synthesis. In this case, all algal species and cyanobacteria for which no data on the possibility of cyanotoxin production are available can be excluded from analysis. If this recommendation is adopted, the list of potentially toxic species (or even an identification guide) must be drawn up to avoid misinterpretation.

Improving the policy framework for the use of potentially toxic cyanobacteria biomass harvested from aquatic ecosystems. A new perspective is needed to assess the role of biomass harvesting in minimizing the risks associated with cyanobacterial cyanotoxins in aquatic ecosystems, as the value chain for the utilization of cyanobacteria harvested from aquatic ecosystems faces major challenges due to the potential toxicity of cyanobacterial blooms, which have led to strict regulation of biomass utilization in the European Union. Legislation should be reconsidered in cases where the use of cyanobacterial biomass poses negligible risks, such as when used as fertilizer for energy plant cultivation or when cyanobacterial biomass is added to increase biogas production, which supports the degradation of cyanotoxins during processing, or when detoxified biomass is used.

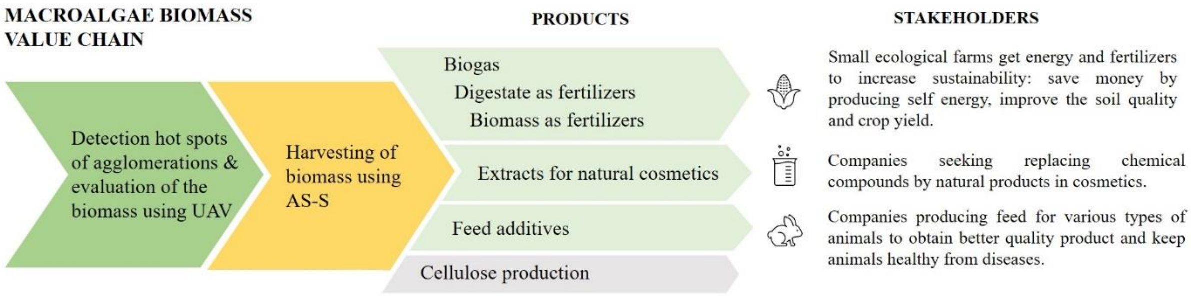
The polluter pays principle can be applied to reduce nutrient loading in inland aquatic ecosystems from point and diffuse sources and to remediate degraded soils. We suggest to offer polluters the choice of either paying fines for the nutrients released by their activities OR harvesting a certain amount of excess macroalgal biomass from aquatic ecosystems and using it as a slow-release algal-based fertilizer to improve soils on their land. This principle can support the restoration of affected ecosystems, raise people's awareness by changing public attitudes towards pollution, and ensure the sustainability of the measures.

Standardisation of new products from wild algal biomass in necessary from the point of legislation. Recirculated products from algal biomass collected in aquatic ecosystems, similarly to the algal biomass grown on wastewater treatment, needs different standardisation of new products and processes for scale-up.

RECOMMENDATION TO BUSSINESS

Algal biomass suitable for efficient harvesting. For efficient harvesting of algal biomass, we recommend using the remote sensing method developed in the "AlgaeService for LIFE" project, which makes it possible to select the best location and determine the approximate amount of algal biomass suitable for harvesting. The density of *Cladophora* biomass must be between 500 and 900 tons of wet biomass/km and there must be at least 0.5–1 km of agglomerations in the selected river section to ensure economic feasibility. The density of the cyanobacteria biomass must be 20–28 kg/m^2 and cover the water surface with a layer of at least 1 cm thickness.

Bioproducts. The project identified the entire value chain for *Cladophora* macroalgae biomass after harvesting in aquatic ecosystems. Depending on the quality and processing of the biomass, it could be used for biogas production, as a fertilizer for horticulture, as a feed additive for animals or to extract valuable compounds as an environmentally friendly substitute for cosmetic products. The diagram shows the value chain of macroalgae biomass from harvesting to bioproducts.



Low-value products from *Cladophora* macroalgae biomass. Macroalgae agglomerations develop at different times depending on the water body: in stagnant waters, the largest biomass is formed in June/early July, in rivers – from August to the end of October. The best and most environmentally friendly time for harvesting in rivers is the second half of August and the first half of September, when most benthic invertebrates pass from the larval to the imago stage and leave the agglomeration in which they live. At this time, the biomass also begins to float and is still in good condition for high-quality bioproducts. The efficiency of biomass collection for bioproducts must be planned in advance to reduce costs and achieve a positive cost balance of the end product. To ensure economic feasibility, small organic farms located near water bodies where algal biomass accumulates should be considered, as an AS-S prototype can collect a total of 2240 tons per harvesting season, allowing a maximum of 195 ha to be fertilized. For small farms raising cattle, a combination of biomass production and subsequent use of the digestate as organic fertilizer could be proposed to achieve a double benefit – energy and fertilizer as digestate from the same macroalgal biomass.

High-value products from *Cladophora* macroalgae biomass. Although there is a great demand to replace chemical compounds with natural ones, the market for high-quality products derived from algae waste biomass is more strictly regulated and requires long certification procedures. The macroalgae extracts from *Cladophora* biomass, containing ingredients of plant origin, must comply with the environmental and safety standards laid down in Regulation (EC) No 1223/2009 of the European Parliament and of the Council of November 30, 2009. A cosmetics company that holds a GMP-ISO 22716 cosmetics certificate can continue the development of further products in cooperation with AMU partners. The commercialization of algae compounds/extracts must be evaluated by an independent laboratory throughout the production chain, e.g. biological identification, harvesting and drying, determination of compounds up to clinical testing and packaging of the final product.