MAR2PROTECT

Innovation Factsheet

Online real-time ecotoxicity biosensor

Problem Solved

Contaminant loads can vary considerably over time and conventional grab sampling is often insufficient to assess the quality of effluents, surface water, or groundwater. Environmental waters contain complex mixtures of chemicals and although targeted analyses can be performed to evaluate nutrient or contaminant loads, frequent testing using conventional methods is expensive, labour-intensive, and difficult to implement at high frequency.

Effect-based methods provide an integrated estimate of water quality for specific modes of biological action and are increasingly being incorporated into environmental regulatory frameworks. However, these methods generally rely on laboratory assays requiring specialised personnel and infrastructure.

The EcoTox-Sensor provides an alternative approach through automated, online and near real-time biological monitoring. The system responds to nutrients and toxicants, generating high-resolution continuous data that supports rapid detection of water quality deterioration.

How It Works

The EcoTox-Sensor uses microbial activity as an indicator of water quality.

The device contains a stable biofilm continuously replenished with fresh algal cells from an internal nursery system. Light and nutrient medium are supplied to maintain an algae-dominated microbial population. Changes in microbial metabolism affect carbon dioxide concentration inside the sensing chamber, and CO_2 measurements are used as a proxy for biological activity and ecotoxic effects.

Unique Value Proposition

The EcoTox-Sensor is a low-cost, online ecotoxicity biosensor capable of near real-time monitoring of nutrients and toxic compounds using naturally occurring algae-based biofilms. Its continuous biological sensing approach provides actionable information for water quality management while reducing dependence on laboratory-based testing.

The AlgaeToximeter II is currently among the leading automated algae biosensors. It relies on periodic sampling and therefore operates online but not strictly in real time. The LAR ToxAlarm uses bacteria-based monitoring and performs analyses at five-minute intervals. Unlike these systems, the EcoTox-Sensor continuously supplies fresh biological material from an integrated nursery to the sensing zone without requiring complex timed-release or cleaning protocols. This architecture: simplifies system design, reduces construction and operational costs, enables continuous biological monitoring, and supports IoT integration and remote deployment.

Result Identification

Technology Short Name

EcoTox-Sensor.

Full Name

Online real-time ecotoxicity biosensor.

Lead Partner

Stellenbosch University (SU), South Africa.

Work Package / Task Related Deliverables

The development of the device was part of WP3 contributing to tasks 3.1 and reported in deliverables D3.1 (Bio and chemical optical-based sensors), D3.5 (Optimization of the integrated sensing system for reliable operation under field conditions), D3.6 (Report of the optimization of the integrated sensing system for reliable operation under field conditions) and 3.7 (Final report on Bio and chemical optical-based sensors).

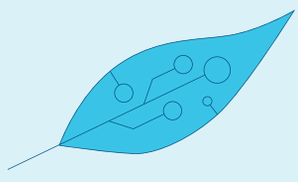
The use of the sensor and pilot installation forms part of WP5 contributing to task T5.6 and reported in D5.4 (Final assessment of the implementation of the MAR2PROTECT technologies in the demo sites).

Current TRL

TRL 5. An initial prototype of the device was tested in the laboratory setting. A field deployable prototype was subsequently developed and installed at an experimental site. Testing remains ongoing.

KER Type

Tool → Sensor System.



- **Efficiency:** continuous monitoring reduces the need for labour-intensive sampling campaigns.
- **Cost:** prototype construction cost is approximately €1,200. Significantly lower than competing technologies. Further reductions are expected through scale manufacturing.
- **Safety:** uses naturally occurring algae. No identified safety concerns beyond those associated with handling monitored water samples.
- **Sustainability:** automated online monitoring reduces laboratory workload and resource consumption.
- **Competitive advantage:** effect-based biological monitoring. Continuous operation. Low-cost architecture. IoT-ready deployment. Rapid detection of water quality changes.

Target Markets & Users

Segment	Description	Role
Water utilities, drinking water/water suppliers	Wastewater-treatment plants, drinking-water utilities and MAR operators monitoring effluent, source-water and recharge-water quality	Primary user; buyer
Industrials (SMEs and large companies)	Industrial facilities using the sensor to monitor the toxicity of discharge streams	Primary user; buyer
Industrials (SMEs and large companies)	Environmental-monitoring companies integrating the sensor into monitoring and data-management services	Integrator; service provider
Government and international organisations	Regulatory authorities responsible for environmental compliance, water-quality control and surveillance	Regulator; policy maker
Academia and research community	Research institutions conducting ecotoxicological studies, technology validation and further sensor development	Research and validation partner

Benefits for Users

The system enables earlier identification of contamination events and operational failures compared with conventional monitoring approaches. This can improve environmental protection, operational efficiency, and public health protection in drinking water applications.

Exploitation Route & Business Model Outline

Exploitation route	Technology licensing, industrial partnerships, or spin-off creation
Revenue model	Hardware sales, maintenance services, data-management solutions, monitoring contracts
IP strategy	Patent (UK and PCT application filed)
Next steps	Additional deployments during 2026, completion of long-term validation programme, engagement with water monitoring stakeholders

Contact **Ludwig Brocker** (ludwig@humefert.com) for codevelopment opportunities, pilot testing, and technical integration discussions. For project coordination matters, please reach out to **NOVA**, coordinator of the MAR2PROTECT project. Collaboration, exploitation, and technology transfer opportunities are supported by **FEUGA**, the project's Technology Transfer Entity.

Discover all the technologies!

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No GA 101082048. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

Funded by the European Union