

Green and innovative technology developed to treat contaminated groundwater

- Microalgae and bacteria combined with vertical biofilters eliminate up to 98% of nitrates and over 90% of pesticides, antibiotics, and antimicrobial resistance genes
- The project has developed two pilot tests of this nature-based solution, showing promising results for improving water quality in rural areas highly polluted by nitrates



Life SPOT pilot plant at Torre Marimon facilities, Caldes de Montbui

Barcelona, April 16, 2025. A study by [the Institute of Environmental Assessment and Water Research \(IDAEA-CSIC\)](#), [the Institute of Agrifood Research and Technology \(IRTA\)](#), [the technology center Eurecat](#), and the companies Facsa, Protecmed, and Nenuphar has, for the first time, demonstrated the seasonal performance of an innovative treatment for groundwater contaminated with nitrates, pesticides, antibiotics, and antibiotic resistance genes. The two pilot plants, located at IRTA's facilities in Caldes de Montbui (Barcelona) and at the water treatment plant in Nules (Castellón), were specifically designed for the project and combine **a novel system of cultivating microalgae and bacteria with a cork and wood biofilter**. This nature-based solution can eliminate both nitrates and other microcontaminants found in well water from areas with high nitrate concentrations, up to 400 mg per litre.

Groundwater is an essential source of drinking water and key to maintaining ecosystems, but it faces increasing pollution from these compounds, particularly in areas with intensive agricultural and livestock activities. Furthermore, its contamination with antibiotics raises concern among scientists due to its potential to foster antimicrobial resistance, a major public health threat. Traditional water treatment methods, such as reverse osmosis or activated carbon adsorption, are effective but expensive and generate waste. These limitations are especially pressing in rural or isolated areas, where **decentralized treatments offer a more sustainable and cost-effective alternative.**

Some of the results of the European [Life SPOT](#) project have been published in [Chemosphere](#) and [Journal of Environmental Management](#). “The system was able to remove **up to 98% of nitrates**, depending on the season, and **over 90% of pesticides and antibiotics** consistently,” explains **Víctor Matamoros**, the researcher who led the study at the IDAEA. “The combination of microalgae and biofilter was key, although the majority of denitrification occurred in the cork and wood biofilter,” he adds.

The metataxonomic study of microbial diversity and functional traits conducted by IRTA revealed that microbial degradation of the wood pellets submerged in water simultaneously sustains anaerobic heterotrophic denitrification processes—biological processes by which bacteria reduce nitrates to nitrogen gas in the absence of oxygen. This significantly reduces nitrate concentrations and most microcontaminants in the biofilter.

Additionally, the biomass generated during the process (the microalgae from the photobioreactor) could be used in agriculture as an organic fertilizer or for biogas production. The results confirm that the harvested biomass does not accumulate contaminants, reinforcing its potential within a circular economy model. To assess the suitability and safety of the treated water, IRTA conducted a demonstration study providing the water to rabbits for 21 days on a demonstration-scale farm. Feed intake and animal growth were assessed, with no adverse health effects observed. In collaboration with IDAEA-CSIC, they also confirmed that the rabbits' faeces contained no antibiotics or antibiotic resistance genes.

Currently, the project partners are focusing on developing the biofilter, as its closed design allows for optimized treatment and the ability to handle greater water volumes. “With a closed biofilter column, water enters at one end and exits at the other, passing through several layers of cork and wood enriched with bacteria that remove nitrates and other contaminants, increasing treatment efficiency in terms of flow rate,” explains **Carme Biel**, IRTA researcher and project coordinator.

Since the tests are being carried out at pilot scale, costs are higher compared to conventional treatment, due to the size of the pumps and other equipment. However, if only the biofilter were used, the equipment and electricity costs would be significantly lower.

According to **David Sánchez**, a researcher at Eurecat, “the study confirms that this technology is a key solution for remote, poorly connected areas far from basic services, as it overcomes the main challenge of reverse osmosis or ion-exchange resins, which is waste management.” “Economically, the biofilter and microalgae technology has lower

overall costs compared to other technologies, and those costs could be further reduced through revenue from carbon credits and biomass sales,” Sánchez states.

The Life SPOT project began in 2019 with the goal of eliminating water pollution caused mainly by agriculture and livestock using alternative nature-based solutions to produce potable water. This technology has been implemented in three rural areas affected by agricultural pollution: Nules (Castellón), Caldes de Montbui (Barcelona), and a peri-urban zone in Perpignan, France. The project has successfully demonstrated the technical, environmental, and economic feasibility of this new groundwater treatment method, which could positively impact 20 million people living in rural European areas.

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Iria Sambruno | Communication IDAEA-CSIC

comunicacion.idaea@cid.csic.es