Study shows the effectiveness of wetlands in removing antibiotics from wastewater treatment

- **A CSIC study reveals that nature-based solutions are more effective than conventional technologies in removing antibiotics and antimicrobial resistance genes from wastewater**

- **The full-scale study demonstrates that these solutions reduce ecotoxicological risks by more than 70% and microbiological impact on surface waters**

Photograph of Can Cabanyes wetland, Barcelona / IDAEA-CSIC

Barcelona, September 2, 2024. Antibiotic pollution in urban and industrial wastewater is a growing problem, especially in southern Europe, where the high consumption of these drugs and water scarcity exacerbate the situation. In this context, a study by the Institute of Environmental Assessment and Water Research (IDAEA) of the CSIC, under the Ministry of Science, Innovation, and Universities (MICIU), and the Karlsruhe Institute of Technology (KIT), reveals that nature-based solutions (NBS), such as constructed wetlands, emerge as effective technologies for improving water quality and reducing emerging contaminants.

This work, published in the journal *Water Research*, evaluated the effectiveness of using nature-based solutions as tertiary wastewater treatment technologies to remove antibiotics and antimicrobial resistance genes on a full scale in the Besòs River and Can Cabanyes (Barcelona), compared to conventional treatments.

The study has shown that surface flow constructed wetlands remove an average of 88% of the present antibiotics, while horizontal subsurface flow wetlands remove 69%, significantly outperforming conventional technologies that combine sand filtration, ultraviolet (UV) light disinfection, and chlorination, which remove between 36% and 39%. Regarding antibiotic resistance genes, conventional treatment systems already offered a 99% reduction; however, the wetlands have demonstrated the ability to eliminate up to 99.9% in both seasonal cycles evaluated (summer and winter).

"Constructed wetlands are treatment systems that degrade materials found in wastewater through physical, chemical, and biological processes that occur in nature. Thus, wetland plants release oxygen and other chemicals through their roots, creating a rhizosphere that promotes the presence of specific microorganisms that accelerate the biodegradation of contaminants," the researchers note. Furthermore, the study has highlighted that these natural solutions also reduce the risk of toxicological impact on ecosystems by an average of 70%, compared to the mere 6% achieved by conventional technologies.

"These findings reveal a promising advance in environmental protection and public health," says **Víctor Matamoros**, a researcher at IDAEA and the study's lead author. "The results underscore the importance of implementing more sustainable treatment technologies in the wastewater sector, as they help minimize the discharge of antibiotics and antibiotic resistance genes into surface water bodies, protecting aquatic ecosystems and combating the growing threat of antimicrobial resistance, which is linked to increasing mortality rates globally."

"Of the 22 antibiotics analyzed, 13 were detected in all water samples, with concentrations ranging between 2 and 1,200 ng/L. Azithromycin, used to treat upper respiratory tract infections or reproductive organ infections, and sulfamethoxazole, employed in combination with trimethoprim to treat urinary tract infections, were the most abundant. These data align with the extensive use of these antibiotics and their low removal rates in wastewater treatment plants," notes **Edward Jair Pastor**, a research trainee at IDAEA.

The study also shows that the use of these wetlands positively changes the water profile, increasing its quality by generating a microbiota more aligned with natural ecosystems and, consequently, reducing the impact on rivers and streams. However, conventional technologies do not show substantial differences in the composition of the microbiological communities affected by wastewater.

Wetlands, therefore, are not only effective but also essential for future wastewater management strategies. This study, part of the European Nature project coordinated by IDAEA-CSIC, paves the way for promoting the use of nature-based solutions as a bridge

between existing wastewater treatment plants and the receiving environment, fostering good chemical and ecological status of surface water bodies.

"Wetlands present a viable alternative for widespread application, aligning with global objectives for water quality and natural resource conservation," concludes Matamoros.

EdwardJ. Pastor-Lopez, Mònica Escola Casas, Dominik Hellman, Jochen A. Müller, Víctor Matamoros. **Nature-based solutions for antibiotics and antimicrobial resistance removal in tertiary wastewater treatment: Microbiological composition and risk assessment**. *Water Research*. DOI: doi.org/10.1016/j.watres.2024.122038

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