



Effect-based Monitoring for Pharmaceutical Pollution in Ireland

Authors: Fiona Regan and Dylan O'Flynn

Lead organisation: Dublin City University

Identifying pressures

Pharmaceutical contamination in Irish surface waters is a growing problem that is intensified by rising pharmaceutical consumption and production. Factors such as geographical location, proximity to waste water treatment plants, seasonal changes, local administration practices and environmental events contribute to the presence of these chemicals in water bodies. The Effect-based Monitoring for Pharmaceutical Pollution in Ireland (EMPIRE) project sought to tackle this issue by identifying sources of pharmaceutical pollution and monitoring Irish surface waters, with a focus on temporal measurements. In addition, the project aimed to assess the effectiveness of ecotoxicology tests in determining the chronic effects of pharmaceuticals and measure toxicity or modes of action using a battery of bioassays on individual pharmaceutical compounds and mixtures. Using this comprehensive approach, the research provided a deeper understanding of pharmaceutical pollution to inform strategies to mitigate its impact on the environment and public health.

Informing policy

The EMPIRE project addressed the significant societal and environmental risks posed by active pharmaceutical ingredients (APIs) in water sources, which can affect wildlife and potentially humans, even at low concentrations. Current risk assessments may not fully account for chronic exposure to low levels of APIs in drinking water, the combined effects of multiple APIs or their impact on vulnerable populations. Urban waste water treatment plants are often unable to remove all APIs, and veterinary pharmaceuticals from manure spread on land can further contaminate surface water and groundwater. The research underscored the need for improved analysis and monitoring techniques, as well as a bioanalytical approach to assessing water safety given the complex mixtures of micropollutants likely to be present in drinking and recycled water. By enhancing our understanding and management of pharmaceutical pollution, this research should inform policy changes, improve public health protections and promote more effective water treatment practices, ultimately safeguarding both human and environmental health.

Developing solutions

The EMPIRE project is the first comprehensive investigation into using effect-based biomonitoring for pharmaceutical pollutants in Irish surface waters. Through a combination of in vivo and in vitro bioassays, the project assessed water quality and highlighted key findings for improving monitoring practices. The research reveals that certain pharmaceutical compounds are consistently present at measurable concentrations, emphasising the need for more frequent monitoring near waste water treatment plants and in surface waters both upstream and downstream. Analytical methods can be influenced by sample conditions such as pH level and storage, requiring careful management of sample matrix interference and the use of suitable internal standards. The project recommends integrating occurrence data with effect-based monitoring to evaluate water toxicity, although standardised bioassays are still needed. In addition, monitoring the effects on ecosystem biodiversity, particularly organism reproduction, is crucial for accurately determining toxicity profiles. The study also stresses the importance of broad chemical screening, noting higher pharmaceutical contamination in urban areas but significant occurrences in rural sites as well.

