



EUROPEAN UNION



# EU MISSIONS

ADAPTATION TO CLIMATE CHANGE



September  
2025

## Securing bathing water quality after extreme storms in Barcelona, Spain

Using real-time data and risk modelling to protect public health and the local economy

*A Quantitative Microbiological Risk Assessment model helps predict, monitor and manage the risks of overflowing sewage systems after extreme rain in combination with storms and their impact on water quality and public health. Testing the solution at an urban beach in Barcelona has proven successful.*

### Key Learnings

- **Early Warning Systems:** Predictive modelling enhances decision-making processes, supporting authorities to act before contamination events pose significant health risks as heavy rainfall can lead to pollution in recreational areas. Untreated wastewater can flow into bathing waters and pose a potential health risk to swimmers.
- **Integration of Quantitative Microbiological Risk Assessment modelling with real-time environmental data:** This provides a valuable tool for proactive water quality management as it enables predicting microbiological risks for bathers in different situations after a sewage overflow and determining the areas which present the greatest risk.
- **Transferability potential:** The methodology and workflow are transferable to other locations facing similar challenges, allowing for adapting the Quantitative Microbiological Risk Assessment model to different water basin environments, when multiple sewage systems overflow during extreme weather conditions.

## About the region

The Catalan coast in North-Eastern Spain spans 600 km along the Mediterranean Sea. The temperate climate supports various habitats, providing valuable ecosystem services. The biggest city on the coast is Barcelona, with a population of 1.6 million inhabitants. Critical infrastructure, major industries, tourism, high urban density, and agricultural production severely compete for limited water resources. Despite limited water availability, occasional heavy rains characterise Barcelona's climate, leading to overwhelmed sewage systems. Bogatell beach, an urban beach in Barcelona is located near a Combined Sewer Overflow.

## Climate Hazards

Flooding, Storms

## Sector

Water Management, Urban, Health, Tourism

## Key system

Water Management, Health and Wellbeing



Figure 1: Location of Barcelona. Image Credit: [Britannica](#).

## Climate Threats

Like many other coasts in the Mediterranean and in Europe, the Catalan coast is highly vulnerable to climate change due to the complex interplay between climate, rich biodiversity and high human activity. Sea level rise is threatening low-lying coasts (especially deltas and estuaries) with increasing flooding risks and salt intrusion, among other impacts. More frequent and intense marine storms affect coastal assets and threaten local species and biodiversity. Water scarcity is a chronic problem, aggravated by climate change and increased tourism, with water supply relying heavily on river transfers, desalination plants, and reclaimed water. Increasing variability in rainfall is exacerbating flash floods – floods associated with heavy rains and occurring in less than six hours – and is causing damage, which is particularly problematic in densely populated areas where marine floods pose an additional threat.

## Assessing the impact of overflowing sewage systems on water quality and public health

Combined sewer systems transport both stormwater and sewage. Under normal conditions, the system directs wastewater to a treatment facility. However, during intense rainfall or storms, the system can become overwhelmed and directly discharge untreated wastewater into nearby water bodies. This overflow system, known as “Combined Sewer Overflow”, was created to prevent urban flooding. These events introduce untreated sewage, pathogens, and pollutants into recreational and ecological environments, increasing risks of waterborne diseases, contamination, and ecosystem degradation. Their impacts on human health can mainly cause gastrointestinal disorders.

Rising global temperatures and more frequent extreme rain events will likely lead to more frequent and more intense occurrences of Combined Sewer Overflow, necessitating improved monitoring and management strategies.

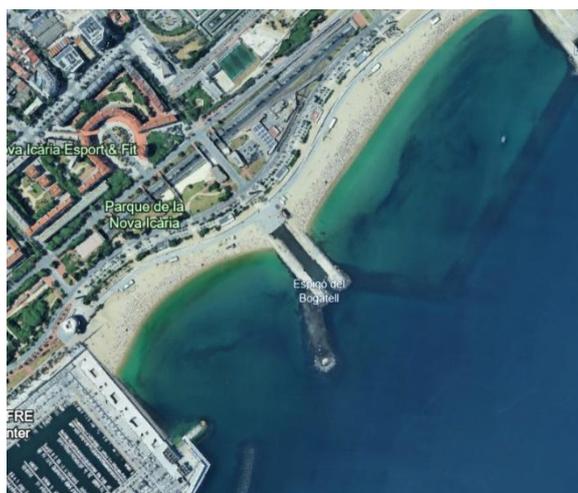


Figure 2: Bogatell channel discharge in Barcelona. Sampling point location. Image Credit: Google Maps.

### Predicting health risks from sewage overflows with real-time data

To estimate the health risk for bathers exposed to contaminated seawater, the [IMPETUS project](#) team developed a Quantitative Microbiological Risk Assessment model and tested it at an urban beach in Barcelona. By combining real-time environmental data, such as weather, sea conditions and sewage overflow events, the model predicts when and where water quality poses a health risk.

It simulates how pathogens spread from the discharge point and estimates concentrations in nearby bathing zones. The model also considers how environmental factors like currents, sunlight and temperature affect pathogen survival.

This tool supports more informed, timely decisions to protect public health after sewage overflows and is transferable to other urban coastal areas facing similar challenges.

*“The Quantitative Microbiological Risk Assessment model represents a valuable approach for proactive water quality management and establishing early warning systems. It predicts the microbiological risk for bathers in different situations of Combined Sewer Overflow and identifies the areas which present the greatest risk.”,*

*Mireia Mesas Suárez, Eurecat (IMPETUS project partner)*

Figure 3 shows how the Quantitative Microbiological Risk Assessment model works to estimate the infection risk from microorganism exposure in wastewater.

First, it collects data on weather, seawater and sewage overflow. Then, it calculates how pathogens spread and how likely they are to cause infections. The figure differentiates the steps included in the Calculation module (in green), the input data needed (in blue) and the different improvements incorporated into the model regarding a preliminary Quantitative Microbiological Risk Assessment model developed in previous projects (highlighted in red).

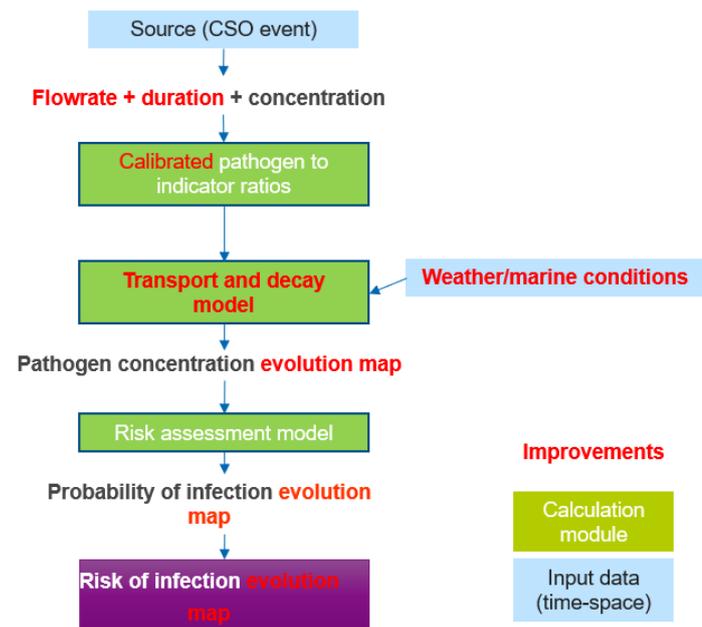


Figure 3: Outline of the QMRA model workflow, upgraded items highlighted in red. Image Credit: Eurecat.

This explains how contamination travels from the discharge point to the surrounding bathing waters.

The model also incorporates degradation processes, which are influenced by environmental factors, such as temperature, solar radiation and salinity. Those parameters can significantly impact pathogen survival and decay rates.

After the sewer discharge stops, the pathogen amount in the water flowing through the discharge channel quickly decreases.

This shows that the contamination in the channel does not last for long, once the overflow event has ended, which is important for estimating how long the bathing area may remain unsafe.

To better prepare for future extreme weather events affecting bathing water quality, simulations with a transport and risk model explored scenarios based on marine currents, wind conditions, and combined sewer discharges. For each scenario, the model predicted pathogen movement and dispersion, estimating swimmer risk and indicating how long a beach might remain unsafe after heavy rainfall. This approach supports decision-making and planning as climate change increases the frequency of such events.

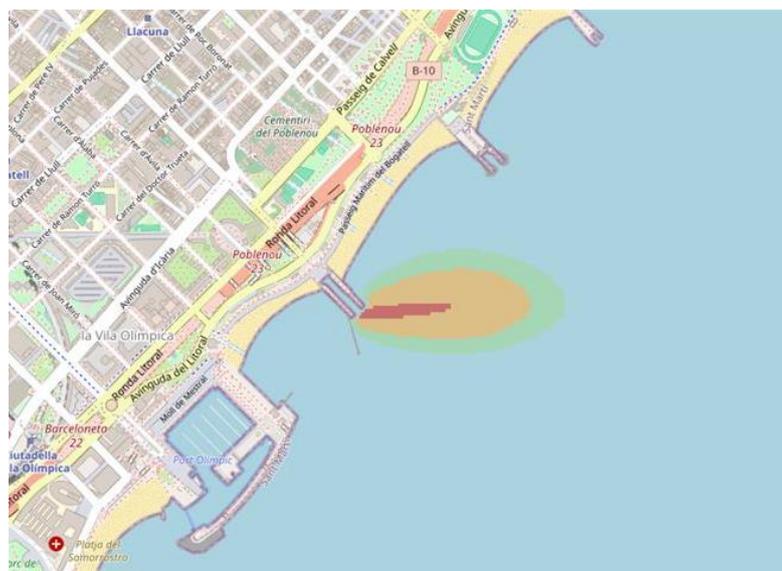


Figure 4: The model output shows the predicted concentration risk, considering the favourable scenario for sea conditions and average CSO intensity (considering 2023-2024 data). Image Credit: Eurecat.

Once in the sea, some pathogens start to lose strength or die due to natural processes; for example, sunlight helps destroy many of them. Warm temperatures and the salt in seawater also affect the survival time of these germs. Therefore, pathogen persistence varies seasonally, showing that degradation rates are higher in summer due to increased sunlight exposure, which supports pathogen degradation. The way the sea moves, especially the speed and direction of currents, has a big impact on how pathogens spread. During spring and autumn, the water

During spring and autumn, the water

currents are generally stronger and more dynamic, which helps to carry away and dilute contaminants faster. As a result, the infection risk usually disappears more quickly in these seasons.

### **Using bacterial indicators to improve risk assessment**

To better estimate health risks from contaminated water, the project team refined the link between commonly monitored bacteria (used as indicators of pollution) and actual disease-causing pathogens. By improving this understanding, the risk assessment model can more accurately reflect real-world conditions for bathers' health.

The sampling campaigns in the case study area supported real-time monitoring of commonly monitored bacteria as indicators, particularly during sewage overflows. This data helped to create more realistic maps, showing where health risks are highest, which in turn supports quicker, more effective decisions on water quality and public safety, including early warnings and targeted actions.

### **Economic contributions, challenges and outlook**

The developed Early Warning System, based on a Quantitative Microbiological Risk Assessment model, helps reduce health risks and prevent unnecessary beach closures by identifying when and where pollution poses a threat. This avoids overly cautious decisions and supports the reputation and economy of coastal areas that depend on tourism. In doing so, the solution benefits both public health and local businesses.

Despite remaining challenges, such as limited access to detailed data and variations in local regulations, this type of tool can play a key role in developing early warning systems for bathing water safety. It enables authorities to act before a situation becomes critical, protecting both public health and the environment.

Looking ahead, integrating artificial intelligence (such as machine learning) could enhance the system by learning from past events to better predict infection risks in future situations, particularly useful for coastal cities aiming to prepare for extreme weather events.

## Summary

Integrating real-time data and modelling tools enables local authorities to make faster, more informed decisions to protect public health. By continuously monitoring sea and weather conditions and predicting pollution spread after heavy rainfall, the system helps anticipate risks and supports timely actions, such as issuing health warnings or temporarily closing beaches. These forecasts are a key climate change adaptation measure, especially as storms causing sewage overflow become more frequent and intense. The solution reduces health risks while avoiding unnecessary beach closures, helping to sustain tourism, an important economic sector in coastal areas. It supports both public health and local businesses and is adaptable to other coastal areas facing similar climate-related challenges. Real-time data from actual “Combined Sewer Overflow” events allows for modelling pathogen spread and potential health risks. Incorporating artificial intelligence could further enhance the modelling system by learning from past events to better predict future overflow severity. While challenges remain, such as limited data availability and varying local regulations, the approach is a valuable tool for early warning systems, enabling authorities to respond proactively and protect both people and the environment.

## Further information

The work presented within this adaptation story is part of the [IMPETUS](#) Mission project

*This Mission project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement 101037084.*

It was funded in the EU Horizon 2020 Green Deal call.

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**Funded by  
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