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Fate and transport modelling of faecal indicator bacteria in Dublin Bay

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Water-based microbial pathogens are often responsible for the spread of waterborne diseases in polluted coastal waters. However, difficulties in directly measuring pathogens have resulted in Faecal Indicator Bacteria (FIB) being commonly used as risk indicators in coastal and bathing water management. FIB groups, particularly those of E coli and enterococci, are easily quantified in laboratory tests and are used worldwide to assess health risks in bathing and shellfish harvesting waters.

Dublin Bay off the east coast of Ireland extends to over 300 km^2 and is home to species and habitats of high conservation importance. Its significant environmental, economic, cultural, recreational and tourism importance to the 300,000 people living within the Bay area and to the wider Dublin population is reflected in its 2015 Biosphere designation from the United Nations Educational, Scientific and Cultural Organisation (UNESCO). Recent years however, have seen an increase in pressures on the water quality in Dublin Bay with diffuse and point source pollution discharges from both the urban and rural catchments connected to the bay being a cause of increasing concern for the responsible authorities charged with managing the coastal waters in the context of national and European legislations, particularly the EU Bathing Water Directive (2006/7/EC).

Here we present the development of a 3-Dimensional numerical model for simulating the transport and fate of FIB (namely E.coli and Intestinal Enterococci) in the receiving waters of Dublin Bay. A dynamic decay rate, which included the effects of salinity, temperature and light intensity was adopted in the model, and was shown to offer advantages over the use of constant decay rate models for simulating the bacterial die-off. More importantly however, the analyses of sediment samples taken from the intertidal zone in the bay revealed relatively high faecal bacteria concentrations. The developed model in this study allows for the effects of sediment on bacteria transport processes in surface waters and in particular, the release of bacteria from sediments into the water column. The model was validated with measurements of current speed and direction at multiple points in Dublin Bay, and with faecal indicator bacteria concentrations (E.coli and Intestinal Enterococci) determined for neap and Spring tides in both wet and dry conditions.

Results from model simulations agreed well with observed data. The model represents a high-level strategic tool that will be used to understand how water quality pressures in Dublin Bay may be altered under different climate change scenarios. The work presented forms part of the EU INTERREG funded Acclimatize project (www.acclimatize.eu/) that is investigating the longer-term water quality pressures in Dublin Bay that may arise in the context of a changing climate.