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Studying transport and decay models for Faecal Indicator Organisms (FIOs) in nearshore coastal waters

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High levels of Faecal Indicator Organisms (FIOs), such as *E Coli* and *Enterococci*, at bathing water sites are linked to disease and public health threats. Hydro-environmental models for coastal areas are important for understanding the transport and fate of FIOs, evaluating effectiveness of environmental management strategies on coastal water quality as well as predicting FIO concentrations in bathing water sites. An important aspect in hydro-environmental models is simulating bacteria decay. Bacteria such as FIOs are generally assumed to undergo a first order degradation, $C(t)=C_0 exp(-kt)$, where $C(t)$ is bacteria concentration at time t; C_0 is initial concentration; k is bacteria decay rate. The bacteria decay rate depends on factors such as temperature, solar irradiation, and suspended solid concentration. A number of bacteria decay models, with various level of complexity, have been developed and applied in different waterbodies such as coastal areas, estuaries, and rivers; there is no consensus regarding to the best model for any given scenario. Generic bacteria decay models have been also attempted but they did not outperform site-specific models. This research evaluates the performance of several bacteria decay models in a data rich test site, namely Swansea Bay, located in South-west of UK. More than 7000 FIO samples were taken at key sources and receptors and analysed over two bathing seasons in two years. Environmental data for stream flows, tide levels, meteorology and water quality are also available. These data are important for hydro-environmental model development, calibration, and validation. This research also provides insights to the key drivers of FIOs at the bathing water sites along Swansea Bay. Hydro-environmental models for the Bay were developed with TELEMAC-2D and -3D hydrodynamic solvers, developed by the Research and Development department of Electricité de France (EDF). TELEMAC-2D solves the two-dimensional Shallow Water Equations (SWE) and TELEMAC-3D solves the three-dimensional Navier Stokes Equations (NSE). The two solvers employ the finite element method on unstructured triangular meshes. The solvers have been used in hydro-environmental studies in coastal areas, lakes, and rivers. Two main decay models were considered in this study; the Stapleton model which considers irradiation and suspended solid effects and the Mancini model which considers irradiation, salinity and temperature effects. King (2019) studied the performance of these bacteria decay models at the case study site and suggested that further improvements might be achieved by combining the two models. In this research, the performance of (i) the Stapleton model, (ii) the Mancini model and (iii) a combination of Stapleton and Mancini model were evaluated against measured FIO concentrations. It was found that one of the key limitations of the hydro-environmental models is that the hydrodynamics of the wet-dry interface in the swash zone may

not be represented accurately. Modelling wet-dry interface remains a numerical challenge; there are different modelling approaches, representing different trade-offs between computational efficiency, numerically stability and scientific accuracy. To compensate for this limitation, sensitivity of FIO concentrations to sampling locations was also evaluated. **Reference:** (i) King JA (2019). https://orca.cardiff.ac.uk/125923/; (ii) Mancini JL (1978). https://www.jstor.org/stable/pdf/25040179.pdf; (iii) Stapleton CM et al. (2007). https://orca.cardiff.ac.uk/40376/