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Combined use of physically based models and geostatistics to understand microbial contamination in the Thau lagoon (France)

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The yearly shellfish harvest in the Thau lagoon (75 km2) is about of 13000 tons of oysters and 4000 tons of mussels, representing 10% of the French shellfish production. The microbiological shellfish quality is directly related to the lagoon water quality which is dependent from the watershed inputs. By dry weather or after rainfall events, the Thau lagoon shells are regularly impacted by microbial pollutions of faecal origin exceeding health standard, resulting in the closure of the shellfish harvest.

To improve the water quality, and in the face of increasing population pressure around the lagoon, the OMEGA Thau project (Environmental Management Tool and Alert Management) was initiated in 2006 (*).

To identify the most critical sources according to their impact on the quality of lagoon water, the hydrodynamics model "Mars 3D" was coupled with models of Escherichia coli mortality in seawater. The calibration and the validation of this coupled model use a data base which was collected simultaneously on the watershed and on the lagoon, after four rainfall events (2007-2009). Measurements include punctual samples of water quality and hydrological parameters (salinity, turbidity, temperature), together with dynamic sampling procedures with a towed multi parameters measurement device (alias Easyfish). Observed and simulated freshwater plume and Escherichia coli levels in the water were compared spatially and temporally in order to choose the optimal parameters of both hydrodynamics and biological models. Dealing with parameters that are spatially and temporally structured (not random), this comparison is based on a geostatistical approach and accounts for the uncertainty attached to observations and their spatial variability. Statistical bias and discrepancies between measurements and model outputs have been observed and led to review some assumptions about input parameters for the physical model.

The paper presents the work achieved on calibration and validation of this coupled model. In particular this tool enabled to understand the underlying processes of water and shellfish E.coli contamination and it was used to determine environmental/meteorological conditions giving the greatest risk of shellfish contamination. Thus, these conditions were those associated with the most critical water and E. coli loads, and those favouring both E. coli survival in seawater and the rapid transfer of E. coli from the plumes at river mouths to the nearest shellfish farming area.

These validated models are part of the environmental management tool developed to guide local authorities to achieve optimal water quality consistent with European standards for shellfish harvesting areas.

(*) Cf submitted abstract by Fiandrino et al.: Escherichia coli Maximum Allowable Daily Loads (MADL): an environmental management tool to improve the microbiological quality of the Thau lagoon water (France)