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Development of a new predictive index (Bathing Water Quality Index, BWQI) based on Escherichia coli physiological states for the monitoring of bathing waters

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Bacterial pathogens introduced in coastal aquatic ecosystems pose a potential public health hazard. Particular attention should be given in this context to the physiological state under which bacteria may persist in natural environments, maintaining their viability properties or evolving into a dormant state. To date, a lot of studies have investigated the distribution of bacterial indicators of faecal pollution focusing on the fraction of viable cells (i.e. that are culturable on standard culture media), nevertheless the presence of cells dormant or that could be potentially resuscitated has almost been neglected. Also the European bathing water Directive (2006/7/EC) refers to time-consuming standard methods, unable to detect quiescent bacteria which can reactivate when ingested by swimmers.

To face this issue, a new index, the Bathing Water Quality Index (BWQI) has been developed, which allows to identify the most favorable coastal zones for recreational use where the microbiological risk for bathers is at lowest levels. It ranges between 0 and 1, from worst to best water quality conditions, respectively. The index was calculated using the DELFT3D-WAQ model results for the estimation of living and dormant Escherichia coli concentrations and of their residence times (in terms of flushing time) in bathing areas. To test the effectiveness of the model, a first experimental trial was performed with the aim of evaluating the contribution of the different physiological states (viable, dormant, dead) of the whole Escherichia coli population. Surface water samples were collected from five coastal stations with different level of anthropic pressure and analysed using a fluorescent antibody protocol based on the use of specific polyclonal immune sera against E. coli. To estimate the fraction of the dormant cells, a protocol procedure was appositely designed for this bacterium. Santa Marinella bathing area (Latium, Italy) was chosen as pilot study area due to the high presence of bathers during summer, the occurrence of episodic spills of untreated wastewaters and low conditions of hydrodynamism which result sometimes in pollution phenomena with consequently high public health risks. The results show that low BWQI values often occurred in the area most frequented by bathers, highlighting a potential risk of microbiological contamination. The index values increased with the increase of hydrodinamism, indicating an improvement of water quality in the bathing area.

This study provides a predictive tool to support the preventive decisions of competent authorities to properly protect bathers' health, stressing the need of improved methods for environmental monitoring.