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Assessment of a Rapid Detection Sensor of Faecal Pollution in Freshwater

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Abstract : Good quality bathing water is a highly desirable natural resource which can provide major economic, social, and environmental benefits. Both in Ireland and Europe, such water bodies are managed under the European Directive for the management of bathing water quality (BWD). The BWD aims mainly: (i) to improve health protection for bathers by introducing stricter standards for faecal pollution assessment (E. coli, enterococci), (ii) to establish a more pro-active approach to the assessment of possible pollution risks and the management of bathing waters, and (iii) to increase public involvement and dissemination of information to the general public. Standard methods for E. coli and enterococci quantification rely on cultivation of the target organism which requires long incubation periods (from 18h to a few days). This is not ideal when immediate action is required for risk mitigation. Municipalities that oversee the bathing water quality and deploy appropriate signage have to wait for laboratory results. During this time, bathers can be exposed to pollution events and health risks. Although forecasting tools exist, they are site specific and as consequence extensive historical data is required to be effective. Another approach for early detection of faecal pollution is the use of marker enzymes. β-glucuronidase (GUS) is a widely accepted biomarker for E. coli detection in microbiological water quality control. GUS assay is particularly attractive as they are rapid, less than 4 h, easy to perform and they do not require specialised training. A method for on-site detection of GUS from environmental samples in less than 75 min was previously demonstrated. In this study, the capability of ColiSense as an early warning system for faecal pollution in freshwater is assessed. The system successfully detected GUS activity in all of the 45 freshwater samples tested. GUS activity was found to correlate linearly with E. coli ($r2=0.53$, $N=45$, $p < 0.001$) and enterococci ($r2=0.66$, $N=45$, $p < 0.001$) Although GUS is a marker for E. coli, a better correlation was obtained for enterococci. For this study water samples were collected from 5 rivers in the Dublin area over 1 month. This suggests a high diversity of pollution sources (agricultural, industrial, etc) as well as point and diffuse pollution sources were captured in the sample size. Such variety in the source of E. coli can account for different GUS activities/culturable cell and different ratios of viable but not culturable to viable culturable bacteria. A previously developed protocol for the recovery and detection of E. coli was coupled with a miniaturised fluorometer (ColiSense) and the system was assessed for the rapid detection FIB in freshwater samples. Further work will be carried out to evaluate the system's performance on seawater samples.

Keywords : faecal pollution, β-glucuronidase (GUS), bathing water, E. coli
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