Quantitative microbial source apportionment (QMSA): studies in UK catchments designed to optimise investments in pollution control

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Article 11 of the EU Water Framework Directive (WFD) requires member states to design a programme of measures to ensure compliance of ‘protected areas’, including bathing waters and shellfish harvesting waters with standards outlined in daughter Directives. This has generated an emerging demand for management of microbial pollution derived from drainage basins discharging to coastal near-shore waters. The primary foundation of evidence-based management in this area is to quantify the different fluxes of faecal indicators from a multitude of catchment compartments. These can be divided into (i) point sources, generally associated with human sewage infrastructure, but also derived from industrial waste water outfalls and (ii) diffuse source pollution, principally derived from livestock farming areas but also associated with urban surface drainage from impervious surfaces.

Quantification of microbial flux, at the catchment scale, requires understanding of the emerging science of catchment microbial dynamics if sampling programmes are to be designed appropriately to deliver robust data for operational decision support. Use of inappropriately collected data, particularly that characterising riverine flux to bathing waters, produces highly misleading information which can produce poorly targeted resource allocation resulting in continued compliance failures.

This paper presents an approach to Quantitative Microbial Source Apportionment (QMSA) developed through over 20 large scale investigations in the UK. Data are presented from highly urbanised catchments, such as the UK’s designated research catchment (the Ribble drainage basin) through to areas impacted by livestock pollution in the absence of human pollution (Brighouse Bay in Scotland). The use of the empirical data from over 200 sub-catchments is used to derive export coefficients for the microbial parameters which facilitate empirically-based predictions of microbial flux, at high and low flows, using satellite derived land use data. This approach, combined with published data on faecal indicator concentrations in sewage effluents and point source discharges, underpins a new screening tool being used by UK authorities to estimate faecal indicator flux at problem sites.

Finally, new empirical studies on the attenuation and control of microbial flux from farm-based diffuse sources are described and evidence of potential reduction in pollution using stream bank fencing and wetland systems is presented and evaluated.