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Fluorescence spectroscopy for field surveillance of THM formation precursors to increase sustainable drinking water treatment for the water industry

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Our understanding of the composition and diversity of dissolved organic matter (DOM) in natural waters is improving rapidly with techniques such as fluorescence spectroscopy. For the water industry issues of the reaction of DOM and different processes used to reduce microbial contamination in water for public supply are a pressing concern. A range of processes can be used but the common disinfection by free chlorine can react with DOM to produce a group of substances referred to as disinfection by-products (DBPs) that have been linked to health concerns. Hence, management at water treatment works aims to remove DOM prior to the disinfection reaction or change the treatment method. Both are costly financially and in terms of process chemical, such as coagulents that work variably with different DOM forms. Hence, enabling methods of catchment management, which have long been associated with tackling other forms of pollution (e.g. N, P) through source-pathway-receptor concepts, are options for the water industry where catchment raw water source management is a possible sustainable addition to conventional treatment. This presentation looks at the requirements and ongoing work to inform source water management options using bench-top fluorescence excitation-emission spectroscopy and hand-held sensors to detect DBP precursors, namely trihalomethanes (THMs), in complex multi-source environments.
We start by introducing the forms of DOM discernible in the fluorescence excitation-emission matrix, how these have been ascribed to different compounds by previous studies and what wavelengths are available for in-situ detection. We then discuss methodology issues for sample storage and standard materials. Then we draw on results from a national set of Scottish catchments and a small catchment study to evaluate relationships between THM compounds from standard assay and GC-MS detection against spectral DOM surrogates, including catchment hydrochemical and spatial data covariates. This is supported by laboratory batch work on potential synergistic interactions for THM formation in mixtures of DOM types from isolated humic substances and amino-acid compounds; where the latter can provide markers for anthropogenic pollution sources such as wastewater and farm effluents. Finally, we conclude on some of the potential for these techniques for catchment raw source water management. We present a circular-sustainability argument whereby the broad range of DOM combinations detectable by fluorescence techniques allows consideration of catchment C-source markers of potential THM formation resulting from disinfection and of the microbial contaminants necessitating the disinfection treatment.