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Tracking organic matter pollution and bacteria using fluorescence-based approaches in a UK Chalk stream

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Fluorescence spectroscopy is a rapidly evolving method for determining freshwater organic pollution. Historically, measurement was confined to the laboratory with a coarse temporal resolution. The development of field-deployable sensors has enabled in-situ, multi-peak monitoring - although challenges remain regarding fluctuating environmental conditions (e.g. pH and turbidity) that can impact on fluorometer accuracy and interpretation. This study aimed to use fluorescence spectroscopy (including in-situ sensors) to detect and differentiate sources of organic matter pollution in a predominantly groundwater fed, sewage-impacted, chalk stream.

High frequency monitoring (15 min resolution for 12 months) was undertaken at two sites on the River Chess, S. England. Two multi-parameter water quality sondes were installed above and below a Wastewater Treatment Works (WWTW) effluent outflow point in a mixed land use catchment (105 km^2). Additional grab sampling was conducted during baseflow and stormflow for laboratory-based nutrient, spectrofluorimetric and bacterial analysis.

All sites had low turbidity (<10 NTU) and stable pH (7.7-7.8), during baseflow, ideal conditions for using in-situ fluorometers. Both the difference in wavelength intensity and the ratio of Peak T (Ex. 275/ Em. 350) to Peak C (Ex. 325/ Em. 470) could differentiate between sites, with an observable variation in response to diel cycles of effluent release downstream. The T:C ratio was able to characterize events with distinct hydrometeorological signatures (e.g. rainfall total, intensity, and antecedence), hence the ratio offers a feasible way of distinguishing between different sources of organic contamination in real-time. Relationships between fluorescence and nutrient/microbial concentrations varied in response to differing landcover (urban extent) and effluent contributions to bulk discharge. Effluent contributions also affected the strength of relationship between cultures and individual wavelength pairs, highlighting the importance of calibrating data for individual systems.

This study highlights that fluorescence is a valuable tool in both fingerprinting organic pollution

and tracing the source across sites of contrasting landcover, and under varying hydro-climatological conditions that occur over event timescales. These findings provide the evidence base to develop a new method of detecting and understanding organic matter pollution events at a time scale that was previously unachievable.