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Evidence of spatio-temporal variations in a shallow groundwater contaminant plume discharging in a small urban stream

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The potential pollution and impairment of stream water quality by xenobiotic organic compounds is one of the threats currently targeted by the enforcement of the European Water Framework Directive in Denmark. These compounds may seep into streams from multiple pathways with very different dynamics not fully understood. In this study, we investigated the spatio-temporal variations of chlorinated compounds discharging from two contaminant sources located in the near vicinity of a confluence of two streams in Denmark. The investigated reach and near-stream surroundings are representative of urban settings, exhibiting high channel alteration and urban features such as drains and sewer outlets. The investigation was carried out by monthly water sampling of groundwater, an in-stream control plane and the hyporheic zone, combined with piezometric heads and stream level flow monitoring over one year. Our study revealed substantial spatial variations locally and temporary affecting pathway contributions and overall contaminant mass discharging to the streams. Variable contributions of the groundwater seepage and drains were identified in the channelized part of the stream. Furthermore, variations in the hyporheic flows between the two streams were found to enhance contaminant transport from a second source located closest to the confluence resulting in significant temporal variations of the overall mass of contaminant discharged. Thus, an in-stream control plane approach was found to be an effective method for integrating multiple and variable discharge contributions quantitatively, although information on specific sources is lost. This study highlights the complexity and variability of contaminant fluxes occurring at the interface between groundwater and urban streams, and calls for the consideration of these variations when designing remedial actions for contaminated sites with the potential to impact streams.

