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LINKING GROUNDWATER CONTAMINATION AND STREAM WATER QUALITY: SCIENTIFIC AND REGULATORY CHALLENGES

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Well-known organic contaminants such as chlorinated solvents and pesticides, as well as new classes of compounds or emerging micropollutants (e.g. pharmaceuticals) are extensively produced, utilized and then discarded in society and subsequently released to streams from multiple point and diffuse sources. To address this, the EU Water Framework Directive requires member states to evaluate all types of contamination sources within a watershed in order to assess their direct impact on water quality. Understanding and accurately and groundwater discharge is thus becoming an increasingly important activity for the hydrological, hydrogeological and contamination investigations of rivers and streams.

At the Technical University of Denmark we have studied these issues with particular focus on characterizing groundwater-surface water interactions (GSI) including quantification of contaminant mass discharge into streams, identification of discharge zone, attenuation processes in hyporheric zone and multiple stressor impact on stream water quality. Recently in-stream dilution has ben investigated, which has significant importance from a regulatory point of view, because regulatory guidelines for streams assume a mixing zone before a water quality standard should be met.

In cases where groundwater contaminant plumes are discharging to streams, determination of flow paths and groundwater fluxes are essential for evaluating the transport, fate and potential impact of the plume. This implies that investigators have the tools to easily and accurately evaluate the governing parameters, including an appreciation of the scale of variability, as well as conceptual models that incorporate the various mechanisms affecting flow. An in-depth field investigation of the Grindsted stream was carried out in 2012, to develop the scientific basis for conducting risk assessments for contaminated sites impacting surface waters. Grindsted stream and surroundings is a well-studied site, affected by two major polluting point sources, Grindsted factory and Grindsted landfill.

Our overall aim of the field investigation was to (i) test the applicability of different methods for mapping groundwater pollution as it enters streams at a complex site, and (ii) perform a risk assessment of the stream's chemical status, including documentation of emerging contaminants. A secondary aim was to identify and ideally separate the entry point for the two plumes to Grindsted stream.

We successfully detected six significant local-scale GSI "contact" zones along a 5 km stream stretch, which were not visible at the regional scale, using systematic temperature measurements. We then correlated the two highly contaminated contact zones, using piezometers placed where streambed temperature measurements were <10°C, to concentrations in downstream surface waters. Transects placed perpendicular to stream flow in the contact zones allowed us to effectively identify the Grindsted factory plume using samples containing a unique compositional footprint of chemicals specific for the contaminated site. Despite a significan in-stream dilution, the highly volatile and toxic compound vinyl chloride was found to exceed the Danish surface water quality criterion for a 5 km stretch.

The field investigations (methods and results), implications for management of contaminant plumes and challenges with respect to multiple stressor impact on streams will be discussed in the presentation.

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