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Complementarities of novel and conventional tracer techniques: how can they help us to better understand streamflow generation processes in headwater catchments?

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Over the past decades geochemical and isotopic tracers have been widely used to obtain insights into internal catchment dynamics and to delineate and constrain hydrological flowpaths. Not only water stable isotopes, but also dissolved silica, major ions and cations can be used to separate hydrographs into different components. Nevertheless, further progress has been stymied by limitations such as unrealistic mixing assumptions, unstable end-member solutions and temporally variable input concentrations.
Here, we investigate the potential for innovative tracer techniques to bring new momentum to our understanding of streamflow generation processes in headwater catchments.
In recent years, new techniques have indeed emerged, each revealing their own advantages and limitations. Pfister et al. (2009) demonstrated the potential for diatoms (unicellular, eukaryotic algae) to help detect the onset/cession of surface runoff and quantify the geographical sources of surface water. More recently, Foppen et al. (2011) used synthetic DNA to characterize hydrological processes, both in surface waters and in the subsurface. Temperature has also been widely used as a tracer. Distributed temperature sensing with a spatial resolution of 0.5m and temporal resolution of 2min via fibre optic cable have indeed been applied to locate lateral inflow in streams (Westhoff et al., 2011). Also, ground-based thermal imagery has been proven to be a simple, practical tool for mapping saturated area connectivity and dynamics (Pfister et al., 2010).
The main objective of this work is to evaluate and discuss the respective complementarities of these techniques by shedding light on both their advantages and limitations. This will be done based on examples from the extensive experimental work performed in the headwater streams of Luxembourg.

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