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Extreme groundwater flooding stimulates microbial metabolic activity and biogeochemical turnover in a major UK aquifer

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Microbial metabolic activity in most aquifers is considered to be low and therefore, biogeochemical cycling rather constant, reflecting the stationary temperature conditions and solute concentrations in groundwater. Substantial groundwater recharge during groundwater flooding events may have the potential to critically alter the carbon and nutrient availability in highly responsive unconfined aquifers.

This study investigates the impacts of intensive groundwater flooding in Spring 2014 on nutrient inputs into a shallow Chalk aquifer in the UK and its consequences for the microbial metabolic activity and biogeochemical turnover in groundwater.

Groundwater levels during the flood event rose by > 10m within a week, at some locations reaching the ground surface. The intensity and timing of groundwater level responses varied in space, with carbon and nitrogen concentrations in a network of monitoring boreholes increasing with further variability in response times to the observed pressure head changes. Quantification of microbial metabolic activity (pioneering the first application of the Resazurin/Resorufin smart tracer system in groundwater) in the observed groundwater boreholes revealed distinct hotspots of metabolism and associated respiration rates. Repeated observations saw baseline conditions being restored at all boreholes within less than a year, with significant variability in the tailing of borehole concentrations and activities.

Our results indicate that in particular for highly responsive unconfined aquifers with relatively short vadoze zone transit times there could be significant event-based variability in carbon and nutrient recharge and related microbial metabolic activity and biogeochemical turnover.