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Water temperature effects on virus and DOC transport during riverbank infiltration

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In the view of global warming and the increase in world population, the demand for efficient treatment methods for drinking water has increased. The potential capacity of riverbank filtration to effectively remove contaminants has been proven. However, during floods river water was found to infiltrate more quickly and at a higher rate into the riverbank, posing an increased risk for groundwater contamination (e.g. Shankar et al. 2009). The effect of seasonal variations in groundwater temperature on virus and DOC removal during passage from a flooding river towards a drinking water well was investigated by numerical simulations. Contaminant removal was estimated for each season using a 3D flow and transport model of a large river and a shallow unconfined aquifer. Water viscosity, density and DOC decay rate were considered to be dependent on water temperature. Groundwater temperatures at respective sites of the Austrian Danube were continuously measured during 2010/2011, when the river water level increased by 5 m twice in summer and winter. Even though no floods occurred in autumn nor spring, the water temperature in the near-river aquifer and in the river were very similar during these seasons and could therefore be also used for our scenarios. Based on published removal rates from respective field experiments under defined hydrological conditions, virus and DOC reduction was studied for i) highly permeable gravel (scenario 1), ii) fine gravel (scenario 2) and iii) fine sandy gravel (scenario 3). Variations in groundwater temperature caused the virus and DOC reductions to differ significantly within the seasons according to our scenario simulations. For scenario 1 and 3 smaller virus reductions were estimated in autumn than in spring because of a higher flow gradient during the flood. In contrast, higher virus reductions were estimated in summer than in winter for scenario 2 due to groundwater back flow into the river and more dilution at higher water temperatures. Less DOC breakthrough was estimated in warmer seasons due to accelerated microbial degradation. Results indicate to consider variations in water viscosity, density and decay rates induced by seasonal water temperature fluctuations, as they are additional effects on virus and DOC reduction.