



## Application of caffeine as indicator for the quantification of recharging wastewater in karst systems – A case study

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The objective of the work was to assess the amount of untreated wastewater recharging highly diluting aquifers with rapid groundwater flow. The well studied karst system of the Gallusquelle spring in southwest of Germany has been chosen to be investigated for that purpose. Caffeine, with its promising indicator properties and the successful application to surface water bodies, has been applied as indicator for the amount of concentrated recharge of untreated wastewater at a karst aquifer. A formula was derived to calculate volumes of untreated wastewater from caffeine concentrations in spring water, independent of the population of the catchment. The calculated mean volume of recharging untreated wastewater, neglecting degradation, was found to be  $2.3 \text{ m}^3 \text{ d}^{-1}$  (dry weather equivalent), which corresponds to 0.5% of the total amount of wastewater in the spring catchment. To take degradation into account and therefore improve the estimations of wastewater volumes at the spring, caffeine degradation was evaluated. Residence of concentrated wastewater recharge was determined using caffeine as indicator. Degradation rates were obtained from degradation experiments. Residence times of 94-104 h and 128-132 h were found during a sampling campaign covering two large spring events. The calculated mean volume of recharging untreated wastewater, considering caffeine degradation, is  $9.2\text{--}16.2 \text{ m}^3 \text{ d}^{-1}$ . These volumes correspond to 1.9-3.3% of the total amount of wastewater.