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Carbamazepine as indicator for potential short-term contamination of karst springs

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Karst aquifers are complex systems which vulnerability is very difficult to assess mainly because of the duality of recharge processes and duality of flow. Recharge to a karst aquifer occurs as diffuse or concentrated (sinkholes and dolines). Moreover, karst aquifers are formed by an unsaturated zone comprising soil, epikarst and unsaturated rock matrix, and a saturated zone formed of highly permeable conduits and low permeability matrix storage. In the case of contamination of groundwater by wastewater effluent polluted water can be either transported rapidly and have short term major risk on spring water quality or infiltrate into fractured rock matrix and therefore have a long term effect on the water quality. In order to identify the risk of wastewater infiltrating into an aquifer, researches have focused to date on the identification of indicative wastewater markers.

Carbamazepine (CBZ) was frequently detected in surface water as well as in effluents of sewage treatment plants, as less than 10% of carbamazepine are usually eliminated during sewage treatment. Moreover, CBZ is not attenuated in aquifers (Heberer, 2002), is unlikely degradable or adsorbed, and can be detected in groundwater (Clara et al., 2004). Therefore, CBZ is considered to be fairly persistent in groundwater (Tixier et al., 2003), and is consequently regarded as an effective wastewater marker.

In this case study, the Jeita spring in Lebanon (spring discharge: 1-20 m^3/s) was monitored and sampled for major ions and micro-pollutants following a combined precipitation/snowmelt events. A total of 28 samples (major ions and micro-pollutants) were taken over a total sampling time of 16 days at interval varying between 4 and 24 hours. Based on the variation with time of discharge and electrical conductivity (monitored every 20 minutes) as well as the concentrations of the major ions, a conceptual model showing the response of the aquifer compartments to the precipitation event was generated. A breakthrough curve of the persistent micro-pollutant carbamazepine shows that CBZ enters the aquifer system through rapid flow pathways, whereas it is heavily diluted with old CBZ free waters stored in the soil/ epikarst zone released as a response to the precipitation event. Furthermore, based on travel times estimated from artificial tracer tests, the distance to the contamination source was estimated and reveals to be relatively small.

References

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