Single event time-series analysis in a karst catchment evaluated using a groundwater model

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The Lurbach-Tanneben karst system (Styria, Austria) is drained by two major springs and replenished by both autogenic recharge from the karst massive itself and a sinking stream that originates in low permeable schists (allogenic recharge). Detailed data from two events recorded during a tracer experiment in 2008 (Oswald et al., EGU2009-9255) demonstrates that an overflow from one of the sub-catchment to the other is activated if the spring discharge exceeds a threshold. Time-series analysis (e.g., auto-correlation, cross-correlation) was applied to examine how far the various available methods support the identification of the transient inter-catchment flow observed in this karst system. As inter-catchment flow is intermittent, the evaluation was focused on single events. In order to support the interpretation of the results from the time-series analysis a simplified groundwater flow model was built using MODFLOW based on the current conceptual understanding of the karst system. The groundwater model represents a synthetic karst aquifer for which the same methods were applied. Using the wetting capability package of MODFLOW, the model simulated an overflow similar to what has been observed during the tracer experiment. Various options of recharge (e.g., allogenic versus autogenic) were used to generate synthetic discharge data for the time-series analysis. In addition, geometric and hydraulic properties of the karst system were varied in several model scenarios. This approach helps to identify effects of recharge and aquifer properties in the results from the time-series analysis. Comparing the results from the time-series analysis of the observed data with those of the synthetic data a good agreement was found. For instance, the cross-correlograms show similar patterns with respect to time lags and maximum cross-correlation coefficients if appropriate hydraulic parameters are assigned to the groundwater model. Thus, the heterogeneity of hydraulic aquifer parameters appears to be a controlling factor. Moreover, the location of the overflow connecting the sub-catchments of the two springs is found to be of primary importance. Thus, time-series analysis of single events can potentially be used to characterize transient inter-catchment flow behaviour of karst systems.