



Contaminant transport modelling on an Irish karst system

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Karstic aquifers represent 25% of the water resources worldwide, and are vulnerable to pollution, especially in regard of the high-flow velocities in the conduits. Therefore, understanding these systems and the study of their vulnerability is of major importance with respect to the effective management of such water resources. The high spatial heterogeneity of karst aquifers is a challenge for distributed modelling approaches attempting to represent accurately such karst groundwater systems. Among the different numerical modelling approaches, coupled continuum pipe flow (CCPF) models (also called “hybrid models”) enable flow to be simulated in the different conduit /fracture/ matrix domains (Ghasemizadeh et al., 2012).

We modelled flow and contaminant transport on a small Irish catchment located in county Leitrim, Ireland. This karst system feeds the Manorhamilton spring through a well-developed network of conduits. Several tracer tests were carried out from different sinkholes on the catchment to the main spring. We used Modflow with the UnStructured Grid (USG) and Connected Linear Networks (CLN) modules developed by USGS (Panday et al., 2013). Its solvers and specific discretisation possibilities allow it to represent complex stratigraphy and flows, which makes it an ideal candidate to model karst systems. However, to our knowledge it has not yet been applied to actual karst systems and calibrated against observed data. We first built a 3D geological model (using MOVE, Midland Valley-Petex) to characterise precisely the aquifer, before simulating flow using Modflow, calibrating against the measured spring discharge. Signal analysis (more specifically multiresolution analysis) methods were used to further investigate the internal behaviour of the model. We then modelled punctual contaminant transport using a tracer test to calibrate relevant parameters. This fully distributed approach enables flow and conservative contaminant transport to be simulated simultaneously in a multi-porosity aquifer (with conduit nodes discretisation that can be independent of groundwater flow cells). Whilst it does require a good understanding of the system, large datasets and a relatively long calibration process, it provides a powerful tool which can be used to further understand the dynamics of the karst aquifer involved and can help inform the management of water resources both quantitatively and qualitatively