Geophysical Research Abstracts
Vol. 14, EGU2012-13515, 2012
EGU General Assembly 2012

Uncertainty in mixing models: a blessing in disguise?

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Despite the abundance of tracer-based studies in catchment hydrology over the past decades, relatively few studies have addressed the uncertainty associated with these studies in much detail. This uncertainty stems from analytical error, spatial and temporal variance in end-member composition, and from not incorporating all relevant processes in the necessarily simplistic mixing models. Instead of applying standard EMMA methodology, we used end-member mixing model analysis within a Monte Carlo framework to quantify the uncertainty surrounding our analysis. Borrowing from the well-known GLUE methodology, we discarded mixing models that could not satisfactorily explain sample concentrations and analyzed the posterior parameter set.

This use of environmental tracers aided in disentangling hydrological pathways in a Dutch polder catchment. This 10 km2 agricultural catchment is situated in the coastal region of the Netherlands. Brackish groundwater seepage, originating from Holocene marine transgressions, adversely affects water quality in this catchment. Current water management practice is aimed at improving water quality by flushing the catchment with fresh water from the river Rhine. Climate change is projected to decrease future fresh water availability, signifying the need for a more sustainable water management practice and a better understanding of the functioning of the catchment.

The end-member mixing analysis increased our understanding of the hydrology of the studied catchment. The use of a GLUE-like framework for applying the end-member mixing analysis not only quantified the uncertainty associated with the analysis, the analysis of the posterior parameter set also identified the existence of catchment processes otherwise overlooked.