Geophysical Research Abstracts
Vol. 16, EGU2014-9280, 2014
EGU General Assembly 2014
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Catchment classification based on a comparative analysis of time series of natural tracers

Christian Lehr (1,2), Gunnar Lischeid (1,2), and Doerthe Tetzlaff (3)

(1) ZALF, Leibniz Centre for Agricultural Landscape Research, Institute of Landscape Hydrology, Müncheberg, Germany, (2) Institute for Earth and Environmental Sciences, University of Potsdam, Germany, (3) Northern River Institute, School of Geosciences, University of Aberdeen, UK

Catchments do not only smooth the precipitation signal into the discharge hydrograph, but transform also chemical signals (e.g. contaminations or nutrients) in a characteristic way. Under the assumption of an approximately homogeneous input signal of a conservative tracer in the catchment the transformation of the signal at different locations can be used to infer hydrological properties of the catchment. For this study comprehensive data on geology, soils, topography, land use, etc. as well as hydrological knowledge about transit times, mixing ratio of base flow, etc. is available for the catchment of the river Dee (1849 km^2) in Scotland, UK. The Dee has its origin in the Cairngorm Mountains in Central Scotland and flows towards the eastern coast of Scotland where it ends in the Northern Sea at Aberdeen. From the source in the west to the coast in the east there is a distinct decrease in precipitation and altitude. For one year water quality in the Dee has been sampled biweekly at 59 sites along the main stem of the river and outflows of a number of tributaries. A nonlinear variant of Principal Component Analysis (Isometric Feature Mapping) has been applied on time series of different chemical parameters that were assumed to be relative conservative and applicable as natural tracers. Here, the information in the time series was not used to analyse the temporal development at the different sites, but in a snapshot kind of approach, the spatial expression of the different solutes at the 26 sampling dates. For all natural tracers the first component depicted > 89 % of the variance in the series. Subsequently, the spatial expression of the first component was related to the spatial patterns of the catchment characteristics. The presented approach allows to characterise a catchment in a spatial discrete way according to the hydrologically active properties of the catchment on the landscape scale, which is often the scale of interest for water managing purposes.