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A geochemical study of the River Lagan, Northern Ireland: Insights into the hydrochemical catchment response

Alexander Russell and Ruth Hindshaw
Department of Earth and Environmental Sciences, University of St Andrews, United Kingdom (awr2@st-andrews.ac.uk)

The management of water resources is rapidly becoming one of the most important issues affecting many societies worldwide. The chemical components of a river are often not directly related to discharge, instead the water chemistry and transit time of a catchment are a function of several parameters including the flow pathways, water sources and the storage of water within a catchment. There is a need to constrain the parameters controlling hydrochemistry if water resources are to be managed efficiently and be protected from anthropogenic influences. This study will present experimental analysis of a small catchment, focusing on the relationship between discharge and hydrochemistry; tracing water sources through the investigation of the hydrochemistry, δ18O and 87Sr/86Sr composition of rain water, groundwater, and stream water.
This study focuses on the River Lagan catchment in Northern Ireland. The lower catchment of the river surrounds the city of Belfast, where it drains into the sea. However, the upper catchment (84.6 km2) is noted to be a natural regime, unaffected by damming and, as such, should provide an ideal opportunity to gain insight into the natural hydrochemistry and hydrologic pathways of the catchment. The bedrock of the area is dominated by the Southern Uplands-Down-Longford Terrane, consisting of greywacke sandstone and mudstone successions. Geochemical data obtained from the Geological Survey of Northern Ireland (GSNI), focusing on stream sediment and soils, suggests there is minimal geochemical variation throughout the upper catchment.
The response of the catchment to rainfall was investigated through a time series, recorded during July and August 2014. This time series included a more intensive hourly series, taken over a period of 24 hours, during a forecast rain event. Potential end-members were also sampled: shallow groundwater samples were taken from a well and regular rain samples were collected. Spatial variability within the catchment area was investigated through the sampling of major tributaries. The water samples collected were analysed for major anions and cations, along with isotopic studies into the δ18O-H_2O and 87Sr/86Sr ratios of the water samples.
Initial analysis suggests that the stream chemistry is not tied simply to dilution by rainwater. Analysis of Ca/Na vs Mg/Na suggests stream chemistry remains relatively homogenous even with a variation of 2 m3/s in discharge. Groundwater and a potential third end-member are suggested to have a greater influence on the hydrochemistry of the catchment than rainfall. A lag in bicarbonate concentration against discharge was observed, suggesting the potential for hysteresis effects.
The data presented will contribute to the growing need for an understanding of catchment hydrochemistry in relation to rainfall and groundwater inputs.