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Identifying catchment typologies by analysing concentration-discharge relationships in Scottish catchments

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Analysing concentration-discharge relationships enhances our understanding of biogeochemical and hydrological processes as it enables to identify sources, transport pathways and lags and can thus inform water pollution mitigation measures. Concentration-discharge relationships are mostly non-linear, site and determinand specific and often depend on antecedent conditions.

To understand concentration-discharge relationships in Scottish catchments, we analysed mean daily discharge and monthly concentration (nutrient and major ions) records of 52 catchments ranging from 50 km2 to 5000 km2 across Scotland. We computed variability indices of discharge and concentrations and investigated export regimes (chemodynamic vs. chemostatic) and archetypes (dilution, enrichment, constancy) according to Musolff et al. (2017). To consider different behaviours during low flows and high flows we applied the split-hydrograph method by Meybeck and Moatar (2012) whereby separate concentration-discharge relationships are described for below and above median discharge. Modifying the hydrograph splitting approach we found that the shape of concentration-discharge relationships can be better described using site and determinand specific optimum splitting quantiles other than the median. Furthermore, we implemented an algorithm to assign the discharge and concentration time series into the rising and falling limb of the hydrograph through baseflow separation by a digital filter. This enables us to investigate hysteresis in the concentration-discharge relationships for individual flow events as well as the entire hydrograph in an objective and reproducible way.

In a next step, multivariate statistics, e.g. cluster analysis and random forests, will be used to link typologies of concentration-discharge patterns and biophysical catchment attributes such as topography, land use/land management as well as soil characteristics.

Understanding the relationship between catchment characteristics and their biogeochemical responses to pressures as expressed by the concentration-discharge relationships will allow us to inform regulatory water quality monitoring strategies, improve existing water quality models, and model mitigation and adaptation scenarios to global change in data-sparse catchments.

References

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