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Effects of streamflow regime on the concentration-flow (CQ) relationships across climate zones: a study across the Australian continent

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Understanding the spatial and temporal variation of concentration-flow (CQ) relationships is valuable to enhance understanding of the key processes that drive changes in catchment water quality. This study used a data-driven approach to understand how the CQ relationship is influenced by catchment flow regimes (baseflow versus runoff dominated) throughout the Australian continent. To summarize the CQ relationship, we focus on the b exponent in a power-law relationship ($C=aQ^b$). We considered six commonly monitored constituents, namely, electrical conductivity (EC), total phosphorus (TP), filterable reactive phosphorus (FRP), total suspended solids (TSS), nitrate–nitrite (NO_x) and total nitrogen (TN), at a total of 251 catchments in Australia. A novel Bayesian hierarchical model was developed to assess a) the impacts of flow regime on CQ relationships, both across catchments (spatial variation) and within individual catchments (temporal variation); and b) how these impacts vary across five typical Australian climate zones – arid, Mediterranean, temperate, sub-tropical and tropical.

We found that for individual constituents: 1) spatial variations in CQ relationships are clearly influenced by the catchment-level baseflow contribution, and these influences differ with climate regions; 2) across climate zones, runoff-dominated catchments (i.e. with low baseflow contribution) have relatively stable CQ relationships, while groundwater-dominated catchments (i.e. with high baseflow contribution) have highly variable CQ patterns across climate zones; 3) within individual catchments, the variations in instantaneous baseflow contribution have no systematic and consistent effect on the CQ relationships. The influence of catchment baseflow contribution on CQ relationships has potential to be used to predict catchment water quality across Australia, with over half the total variability in concentration of sediment, salt and phosphorus species explained by variations in catchment-level baseflow contribution.