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Temporal stability of water chemistry spatial patterns across French temperate ecoregions

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Human activity has polluted freshwater ecosystems across the planet, harming ecosystems, human health, and the economy. Improving water quality depends on identifying pollutant sources in river networks, but pollutant concentrations fluctuate in time and continuous monitoring of many points in river networks is expensive (Skeffington et al., 2015), impeding progress in developing countries where water-quality is degrading fastest (Crocker and Bartram, 2014). In a previous study, Abbott et al. (2018) showed that spatial patterns of water chemistry were unexpectedly stable over time in two mesoscale catchments (ca. 360 km^2). In this study, we tested the stability hypothesis at a larger scale, by analyzing 4,523 water chemistry time series of ten chemical compounds (NO_3-, PO43-, TP, DOC, SO42-, Cl-, Na+, Ca2+, Mg2+, K+) across four temperate ecoregions in Metropolitan France (ca. 560,000 km^2). We quantified the spatial stability of water chemistry across the monitoring stations using Spearman's rank correlations between instantaneous concentrations and water quality metrics derived from a 6-year time series (2010 – 2015). The strength of this rank correlation represents how well a water quality evaluation metric can be characterized with a single sampling for a given water quality parameter. Results show that a single sampling captured a mean of 88% of the spatial variability of these parameters, across ecoregions with different climate and land-use conditions. The spatial stability resulted both from high spatial variability among sites and high temporal synchrony among time series. These findings demonstrate that temporally sparse but spatially extensive water sampling can achieve two of the major goals of water quality monitoring: identify pollutant sources and inform ideal locations for conservation and restoration interventions.

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