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The city challenge: quantifying surface water sources in large urban areas using stable isotopes

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Large urban areas comprise a heterogeneous mosaic of land covers that can differentially partition precipitation into “green” and “blue” water flow paths. Stable isotopes, combined with climatic and hydrometric measurements, have outstanding potential to quantify water sources, partitioning into different flow paths and ages in surface waters draining catchments affected by urbanisation. While isotope applications are an established method in many experimental catchments, surprisingly few studies have been conducted in urban environments to quantify water partitioning in areas of different urban land use, with contrasting mixes of impermeable and permeable urban surfaces. In this study we address this research gap, through a multi-scale study in Berlin. Synoptic sampling of precipitation, surface and groundwater was conducted across different spatial scales (ranging from 0.02 to 900 km^2) to quantify the influence of groundwater, effluent, urban storm runoff and evaporation on the city’s major surface waters. Isoscape maps of the city created from Berlin-wide sampling of all major tributaries draining into the Spree and Havel systems showed significant summer influence of evaporation as surface waters flow through the city, local groundwater inflows from smaller tributaries and a major contribution of effluent discharge. Repeat surveys during the winter show the shifting contribution of these different source components and an increased influence of urban storm runoff. Such isotope studies will lead to a better understanding of urban water partitioning necessary for a sustainable urban water management in the future.