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Sources and dynamics of Rare Earth Elements in an urban river under geogenic and anthropogenic influences: the Jalle River (Bordeaux Metropole, France)

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The aquatic ecosytems of industrialized countries are confronted to different degrees by anthropogenic pressures that generate metal pollution, particularly in urban areas. This study is based on hydrogeochemical monitoring of Rare Earth Elements (REEs), Al and Fe in dissolved and particulate phases (n=35) over a 2-year period at the outlet of the Jalle River (Q=1.80 m^3s^{-1}; A=330 km^2), that drains Bordeaux Metropole, discharging directly into the Gironde Estuary (France). This monitoring was supplemented by intermittent sampling on 4 sites to characterize the upstream catchment as well as effluents from a wastewater treatment plant (WWTP) and runoff from the outlet of the main stormwater collector draining a part of the Bordeaux highway. The objectives of this study were to analyze the spatio-temporal variability of concentrations, to identify controlling factors and to evaluate the contribution of different sources to the fluxes exported by the Jalle River. We demonstrated that the upstream catchment strongly influences the geochemical composition of the Jalle waters for Al, Fe, and REEs and that it contributes the bulk of dissolved metal inputs (e.g. >95% for Al and REEs) except for Gd_d (71%). The effluents from the WWTP affect the quality of the Jalle waters by significantly increasing Gd_d by contributing 25% to exported fluxes. The runoff from the stormwater collector (excluding major storm events) influences the Jalle River only more intermittently for, dissolved concentrations. Anthropogenic loads do not seem to affect the particulate concentrations of the Jalle River, contrary to observations made during a major storm event analyzed with high temporal resolution. Such a difference could be explained by the sampling strategy implemented for this monitoring operation which would underestimate particulate emissions mostly transmitted during the first flush of the event. The WWTP therefore remains the main anthropogenic source in the watershed. To conclude, we propose a first version of a conceptual model on the dynamics of dissolved and particulate REEs in a watershed subject to anthropogenic urban pressures, according to hydrological and meteorological conditions