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Impacts of anthropogenic pressures on the water quality of the Gironde Estuary (SW France) from the Urban Agglomeration of Bordeaux: spatial characterization and inputs of trace metal elements (Ag, As, Cd, Cu, Pb and Zn)

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Recent European legislation (2000/60/CE) has listed eight trace metal elements as priority toxic substances for water quality. Urban metal inputs into hydrosystems are of increasing interest to both scientists and managers facing restrictive environmental protection policies, population increase and changing metal applications. The Gironde Estuary (SW France; 625 km^2) is known for its metal/metalloid pollution originating from industrial (e.g. Cd, Zn, Cu, As, Ag, Hg) or agricultural sources (e.g. Cu) in the main fluvial tributaries (Garonne and Dordogne Rivers). However, little peer-reviewed scientific work has addressed the impact of urban sources on the Gironde Estuary, especially the Urban Agglomeration of Bordeaux ($\sim$1 million inhabitants) located on the downstream branch of the Garonne River. In this study, a snapshot sampling campaign was performed in 2011 for characterizing the spatial distribution of dissolved and particulate metal/metalloid (As, Ag, Cd, Pb, Zn, Cu) concentrations in three suburban watersheds: the Jalle of Blanquefort (330 km^2), Eau Bourde (140 km^2), and Peugue (112 km^2). Furthermore, particulate metal Enrichment Factors (EF) were calculated using local geochemical background measured at the bottom of a sediment core (492 cm). Results indicated that metal concentrations displayed a high spatial variability depending on the suburban watershed and the studied element. Local concentrations anomalies were observed for: (i) As in the Eau Bourde River in dissolved (4.2 μg/l) and particulate phases (246 mg/kg; EF= 20) and attributed to a nearby industrial incinerator; (ii) Zn in the Peugue River with maximum dissolved and particulate concentrations of 87 μg/l and 1580 mg/kg (EF=17), respectively, probably due to urban habitation runoff; (iii) Ag in the Jalle of Blanquefort River with high dissolved (74 ng/l) and particulate concentrations (33.7 mg/kg; EF=117) due to industrial activities in the downstream part. Based on hydro-geochemical monitoring of both suburban rivers and local wastewater treatment plants (WWTPs), we present a first estimate of metal/metalloid fluxes and compare them to the respective loads in the Garonne River. Our results suggest that suburban metal inputs may significantly increase metal concentrations and fluxes in the fluvial Gironde Estuary, especially for Ag due to inputs exported by WWTPS and the Jalle of Blanquefort River.