Impacts of highway run-off on trace metal contamination in a small urban watershed: a case study of Bordeaux Metropole (SW France)

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Road dust enriched in traffic-derived contaminants (e.g. abrasion of braking system and tires, exhaust particles, etc.) is a major metal source to urban watersheds due to run-off, especially during rain events occuring at short timescales.

High temporal resolution of run-off (15 samples in 4h) and river water (24 samples in 24h) were sampled during a major summer rainstorm (>50 mm) in the Bordeaux Metropole, after a dry and high vehicle-density period. Run-off was sampled at the outlet of the drain of the Northern part of Bordeaux Highway (NBH; ~135,000 vehicles per day) and river water in the downstream Jalle River ($Q=1.80$ m^3s^{-1}; $A=330$ km^2). Annual dissolved and particulate trace metal fluxes in the Jalle River were obtained from daily monitoring of discharge and suspended particulate matter concentrations and metal concentrations in discharge-weighted cumulates of water and particles over 12 months (2016-2017). The studied metals include the elements identified by the EU Regulation, and emerging metals (e.g. platinum).

Dissolved and particulate concentrations in highway run-off at NBH showed contrasting patterns of sharp short time peaks (few minutes). Copper (Cu) and zinc (Zn) showed the highest concentration variations in NBH and an estimated total metal flux into the Jalle River of 4.3 $kg.4h^{-1}$ and 9.6 $kg.4h^{-1}$, mainly in the particulate phase (62% for Cu and 76% for Zn). During the rainstorm, in the Jalle River, estimated total Cu (5.6 $kg.d^{-1}$) and Zn (13.9 $kg.d^{-1}$) fluxes occurred to ~82-86% in the particulate phase. Consequently, Cu and Zn fluxes in run-off and included road dust contributed 76% (Cu) and 67% (Zn) to total metal fluxes in the Jalle River during the 4h rainstorm. These fluxes are equivalent to >10% of respective annual metal fluxes in the Jalle River.

Better quantification and understanding of traffic-related metal inputs into aquatic systems is necessary to (i) assess their potential environmental impact, (ii) develop efficient run-off purification strategies and (iii) recycle metals, especially in a context of growing metal including emerging and Technology Critical Elements (e.g. REE and PGE) in vehicles.