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Annual budget of Gd and related Rare Earth Elements in a river basin heavily disturbed by anthropogenic activities.

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The real environmental impact of micropollutants in river systems can be difficult to assess, essentially due to uncertainties in the estimation of the relative significance of both anthropogenic and natural sources. The natural geochemical background is characterized by important variations at global, regional or local scales. Moreover, elements currently considered to be undisturbed by human activities and used as tracers of continental crust derived material have become more and more involved in industrial or agricultural processes. The global production of lanthanides (REE), used in industry, medicine and agriculture, for instance, has increased exponentially from a few tons in 1950 to projected 185 kt in 2015. Consequently, these new anthropogenic contributions impact the natural cycle of the REE. Gd and related REE are now worldwide recognized as emergent micropollutants in river systems. Nevertheless, there is still a gap concerning their temporal dynamics in rivers and especially the quantification of both the anthropogenic and natural contributions in surface water. The acquisition of such quantitative information is of primordial interest because elements from both origins may present different bioavailability and toxicity levels.

Working at the river basin scale allows for quantifying micropollutant fluxes. For this reason, we monitored water quality and discharge of the Alzette River (Luxembourg, Europe) over two complete hydrological cycles (2010-2013). The substantial contamination, is principally due to the steel industry in the basin, which has been active from 1875 until now, and to the related increase of urban areas. The particulate and dissolved fractions of river water were monitored using a multitracer approach (standard parameters for water quality including REE concentrations, Pb, Sr, Nd radiogenic isotopes) with two sampling setups (bi-weekly and flood event based sampling). This extensive sampling design allowed quantifying the annual budget of the REE in the particulate and dissolved fractions of the river water and the waste water treatment plant effluents.

Enrichments in Gd have been observed for the dissolved fraction of the water during low water levels. This enrichment has not been detected in the surrounding soils of the basin and can be related to the effluents of the waste water treatment plants, which control the REE chemistry of the dissolved fraction during the low water period. When flood events occur, the Gd anomaly progressively disappears and gives way to the chemical signature of the basin soils. The REE and intense hydrological monitoring we performed at the same time allowed for the annual quantification of the anthropogenic vs. natural REE fluxes in the river water of this heavily polluted basin.