

Changes in sediment-associated trace element concentrations in the Seine river basin (1994-2001)

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Abstract. In the 1980's, based on the concentrations of particulate-associated Hg, Cd, Pb, Cu and Zn relative to very low natural background levels, the Seine River Basin was one of the most impacted in the world. Over the past 20 years, there has been a general decline in these elevated concentrations that parallels declines in Paris sewage sludge trace element levels. Within the basin, marked differences in spatial and temporal geochemical patterns have been observed: (1) between major tributaries, (2) between trace elements, and (3) with stream order and population density, all of which illustrate the complexity of the geochemical processes ongoing in the basin.

1. OBJECTIVES AND METHODS

Since 1994, within the PIREN-Seine programme [1], spatial and temporal changes in sediment-associated trace element concentrations have been monitored in the Seine River Basin by the collection and subsequent chemical analysis of fresh floodplain deposits [1-4]. These analyses have led to: (1) the determination of natural background levels; (2) the identification of trace element spatial distributions within a contaminant gradient; (3) the determination of trends for major contaminants; and (4) the identification of the most affected elements.

Samples mainly were collected from fresh floodplain deposits directly after each flood, along the Seine mainstem from the headwaters (fig. 1A) to Poses, at the river mouth [4]. Additional samples were collected along major (e.g., Marne, Oise), and some minor tributaries (group stations, fig. 1B). Small monolithogenous forested basins (typically $\leq 10 \text{ km}^2$) were sampled as well, to characterize the elemental composition of fine streambed deposits ($< 100 \mu\text{m}$) and were aggregated into lithologic categories including: (1) clays; (2) limestones; (3) miscellaneous carbonates; (4) sands; (5) crystalline rocks; and (6) chalk. Samples were digested with a combination of HNO_3 -HF-HCl, then analysed by GFAAS for Cu and Pb, and by AAS for Al, Fe, Mn and Zn. Hg was analysed by atomic fluorescence after reduction of the digestate with SnCl_2 [4]. These data ($n = 160$) have been compared to those generated from the regular French national river monitoring programme (RNB), ongoing since 1981, at some 50 sites (coarser bed sediments collected on a variable frequency of 0.3 to 2 y^{-1}).

2. THE SEINE BASIN AND ANTHROPOGENIC IMPACTS

The Seine River Basin has low to medium elevations (99% $< 550 \text{ m}$) and is essentially sedimentary (fig. 1A). Runoff is relatively low (5 to 10 $\text{L}\cdot\text{s}^{-1}\cdot\text{km}^{-2}$). Sediment fluxes are some of the world's lowest (10 $\text{t km}^{-2} \text{y}^{-1}$) for a large basin; hence, the river system is particularly