Evolution of suspended particulate matter quality collected by particle traps during the deployment phase: influence on trace metal/geochemical tracer concentrations

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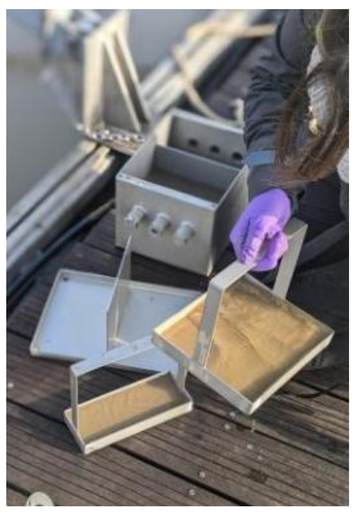


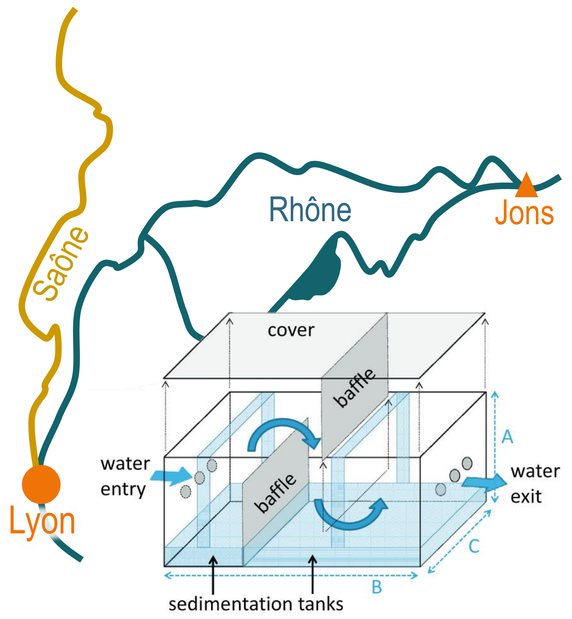
Introduction

In the context of regulatory monitoring of sediment contaminants, particle traps (PTs) represent an alternative method for sampling suspended particulate matter (SPM). These traps enable time-integrated collection of SPM, target the finest and most contaminant-bearing fractions, and can be easily deployed on a large spatial scale. They also provide an effective means of sampling SPM from different tributaries to identify the origin of SPM at river and stream outlets using their geochemical fingerprints. However PT sampling can introduce bias, in some studies, PT underestimates metal concentrations compared to reference (continuous flow centrifugation – CFC).

Objective : understand the mechanisms responsible for potential bias in metal concentrations in SPM collected using PTs,

A. Through an **in-situ approach**, by studying different deployment conditions of PTs on the Rhône River (Jons)

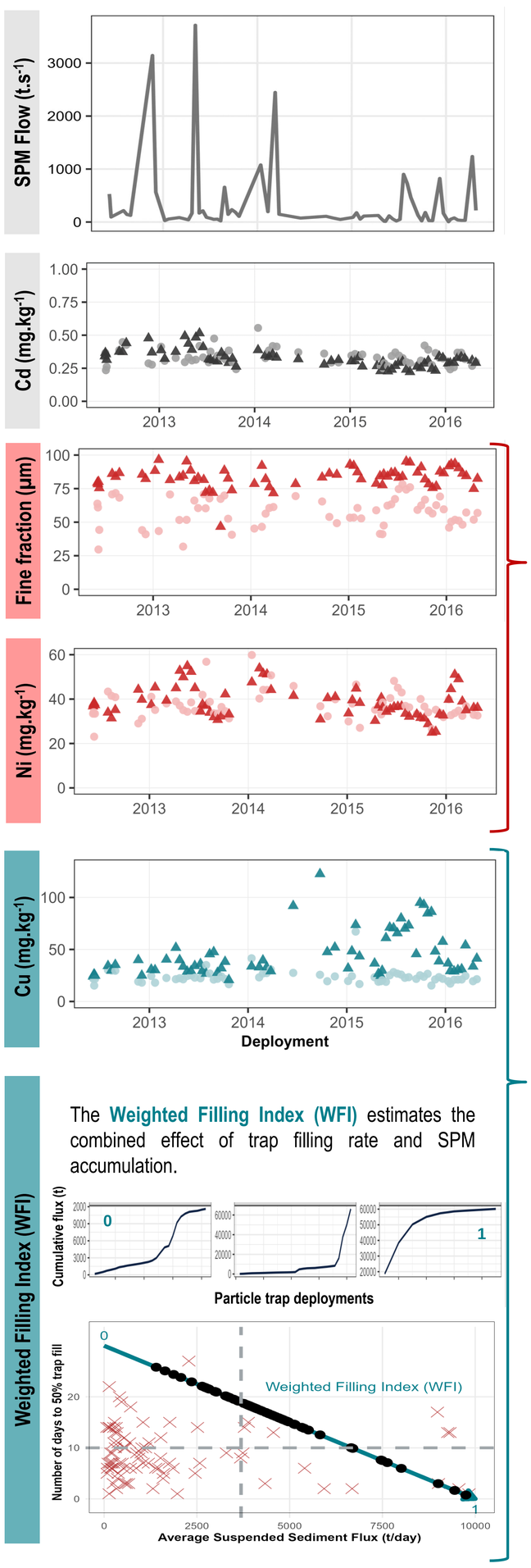
B. Through an **experimental approach**, conducted under controlled laboratory conditions.



A - Long term monitoring

Ten years of monitoring in the Rhône River at Jons (n = 83) provided insight into PT-related processes by comparing metal concentrations in SPM collected with PTs (dark triangles) and CFCs (light circles).

In situ monitoring

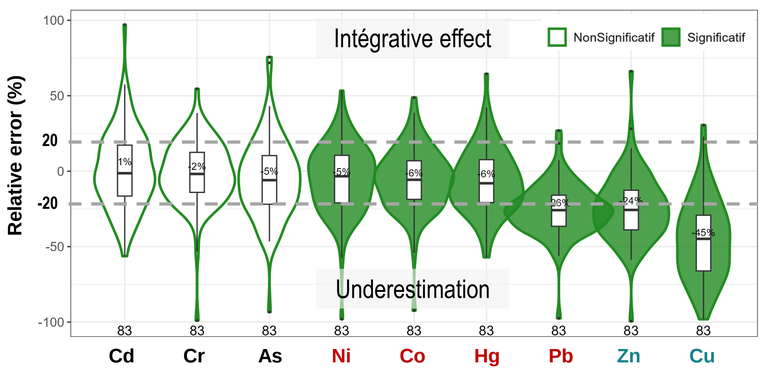


Bias linked to trap sampling

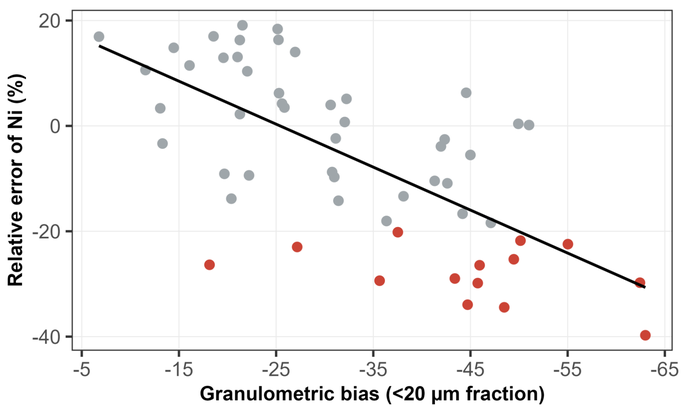
Estimates metal over or underestimation by PT compared to CFC.

$$C_{REFi} = \frac{m_1 \times C_{start} + m_2 \times C_{end}}{m_1 + m_2}$$

$$Relative\ error\ \% = (C_{PT} - C_{REFi}) / C_{REFi}$$

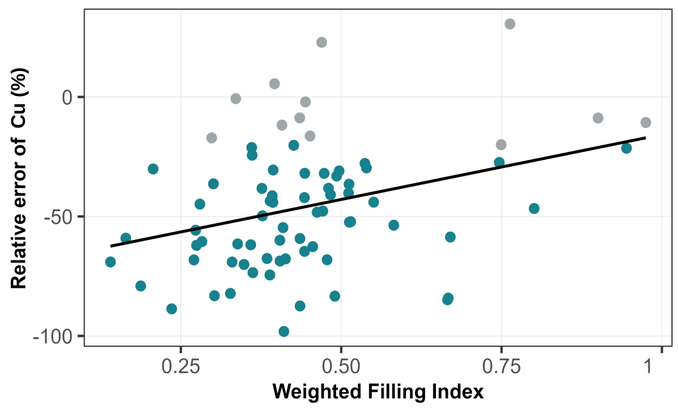


Grain-size bias :



The coarser distribution of PT samples **affects Ni concentrations** (same for Co, Hg, and Pb).

Effect of deployment conditions :

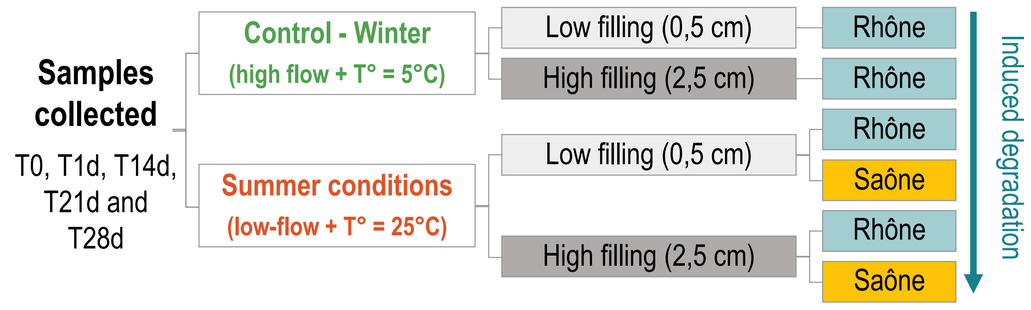


Deployment conditions that cause particle degradation (filling rate and particle residence time) **affect Cu concentrations.**

The underestimation of Pb and Zn can be explained by a combination of several processes.

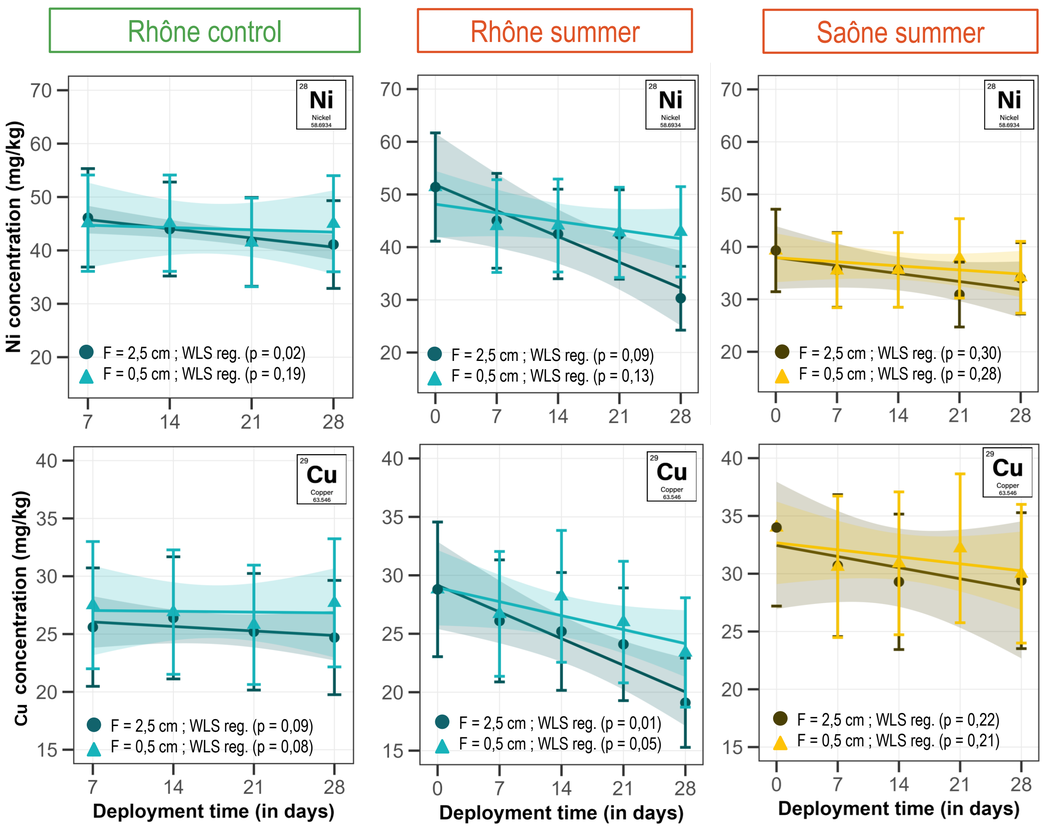
B - Experimentation

Controlled laboratory experiments were designed to replicate biogeochemical degradation of particles and explain biases in metal concentrations observed in situ. Key parameters tested included oxygen renewal, temperature and particle origin.



Preliminary results on total Ni and Cu concentrations

The experimental setup simulates the biogeochemical processes observed in situ under low-flow (drought) conditions.



Rhône :

- No significant decrease in Cu or Ni concentrations under control conditions.
- Significant decrease in Cu concentrations under low-flow conditions.

Saône :

- No significant decrease in Ni and Cu concentrations under either low-flow or control conditions

Filling (F) for the "Rhône summer" condition :

- Low filling (0,5 cm) : -19% Cu from T0 to T28
- High filling (2,5 cm) : -34% Cu from T0 to T28

Microbial-driven degradation

Conclusions

- Degradation processes affecting Cu and Zn concentrations in SPM were evidenced both by long-term monitoring in the Rhône and through controlled experiments.
- Deployment conditions, notably trap filling rate and particle residence time, significantly influence metal concentration in PTs.
- PTs proves to be a reliable tool for SPM collection in the Saône, but their use is limited in the Rhône during 28-day deployments in periods of low flow, for Cu monitoring.
- Evaluating both the robustness and representativeness of SPM collected by PTs, is essential when used for SPM fingerprinting or contaminant monitoring.

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This study was supported by CONTASAONE