Multi-decadal records of PCBs and PCDD/F in Rhône River sediment cores

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Since few decades, the human impact on the natural environment has accelerated: the degradation of the water quality is one of the consequences.

Identification of historical trends in contaminant concentrations in rivers can contribute to improve risk assessment

→ Not available for most large rivers

Sediment cores constitute excellent witnesses of the functioning of river systems and human impacts over decenal time scale:

- document hydro-sedimentary dynamics,
- assess historical and spatial trends,
- evaluate the effectiveness of environmental policies.

PCBs, PCDD/F
Studied sites

Depositional zones adjacent to the channel
(secondary channels and other backwater areas)

The Rhône River
Basin of 97800 km²
Mean annual discharge 1040 m³/s
Methods

**ETL 10-02**

- **Fine Fraction (%)**
  - 0 0.2 0.4 0.6 0.8 1

- **Core Depth (cm)**
  - Chernobyl Fallout (April 1986)
  - Instantaneous deposits
  - End of quarry activity (1980)

- **$^{137}$Cs (Bq/kg)**
  - 0 20 40 60

- **Sum of PCBI (µg/kg)**
  - 0 4 8 12

[Diagram showing core depth, $^{137}$Cs levels, and PCBI values with indicated time periods.]
Methods

Age-depth model for ETL core

Estimated date of sediment deposition

Core Depth (cm)

ETL
Hydro-sedimentary dynamics

Sediment accumulation rate (SAR)
Fluvial annexes: from 1.5 to 6.9 cm/yr (3.6 cm/yr)
Lake (PAL): 0.2 cm/yr
Hydro-sedimentary dynamics

SAR
Fluvial Annexes: 1.5 to 6.9 cm/yr. (3.6 cm/yr.)
Lake (PAL): 0.2 cm/yr.
Riverbanks: 7.6 to 15.2 cm/yr.
PCBI concentrations and profiles varied considerably within and between the sites.

Maximum PCBI concentrations were lowest upstream and increased downstream to a concentration of 417.1 μg/kg at GEC.

Sedimentary layers exceeding the recommended threshold (60 μg/kg) for dredging are larger downstream.
PCB congener profiles as an indicator of sources?

Other Tributary (Isère), Punctual source?

Flood deposits

Lyon city

Other Tributary (Bourbre), Punctual source?
Spatial trends in PCBs at the scale of the Rhône River and changes through time

Separation in time windows (TW):
Spatial trends in PCBs at the scale of the Rhône River and changes through time

Mourier et al. 2014, STOTEN

Tributary 160 µg/kg (85-95)
Spatial trends in PCBs at the scale of the Rhône River and changes through time

Environmental regulation of **point sources** enacted since 1975 and 1986 reduced the PCB burden recorded in sediments.

Recent concentrations (> 2005) are stable and correlated with the cumulated population of the basin:

- Diffuse contribution of urban areas and associated industrial zones
Are PCDFs and PCDDs still a concern in the Rhône River?

PCCD/Fs in the list of priority substances - WFD (2013)

- Maxima concentrations peak between 1980 and 1985
- Rapid and substantial decreases in dioxin concentrations

To evaluate the rate of change in concentrations, PCDD/F concentrations were regressed against date in each core.

Beginning of the regression were chosen at the date of peak concentration.
All of the trends were downward and significant ($p<0.005$).

Reductions in the cores from 1992-2010 for SPCDD/Fs average 83%.

- The rapid decreases in dioxin concentrations coincide with EU target, which aimed to achieve a 90% reduction by 2005, compared to the 1985 level.

- Risks caused by dioxins in biota have been greatly reduced (<10% TEQ),

- Continued trend monitoring at a few sites in the watershed will be a sufficient management response.

Are PCDFs and PCDDs still a concern in the Rhône River?

Van Metre, PC et al. (accepted, ES&T)
Conclusions

→ **Sediment core**: document current and past evolution of the fluvial environment

→ Better knowledge of the spatio-temporal release of PCBs and PCDD/F at the River scale

→ Evaluation of the effects of environmental policies

→ Recommendations for management operations on sediment stocks
Contaminant mobility in dam sediments

Poster of Franck Frémion
Thank you!