

SPATIAL DISTRIBUTION OF PCDD/Fs IN SURFACE SEDIMENTS OF LAKE MAGGIORE (ITALY)

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Introduction

Lake Maggiore is the second largest Italian lake, with the northern third residing in Swiss territory. The important tributaries are River Ticino (Northern inlet) and River Toce (Western inlet). The River Ticino leaves LM at the southern end and connects LM to the River Po.

Extensive monitoring of a series of persistent organic pollutants (POPs) in sediments, plankton, benthic organisms, bivalves and fish was initiated in by the International Commission for the Protection of the Italian –Swiss waters (CIPAIS) in 1996 and is still being continued. Particular concern arose from the contamination with DDT and its metabolites, which exceeded Italian and EU levels for consumption in fish¹, and was detected in bird eggs from fish feeding species as well². The aim of the present study is to supplement the existing data on POPs with sediment levels of PCDD/Fs, where so far only few data³ are available for LM.

Materials and Methods

Sediment samples (0-10 cm) were taken with a Ponar Grab Sampler during 2005. The samples were stored at 4°C until wet sieving < 2mm and were subsequently freeze dried and homogenized. 30 g dry weight samples were Soxhlet-extracted for 24h using n-hexane/acetone (220/30). The analytical methodology follows USEPA method 1613 applying 16 carbon-13 isotope labeled internal standards and HRGC/HRMS.

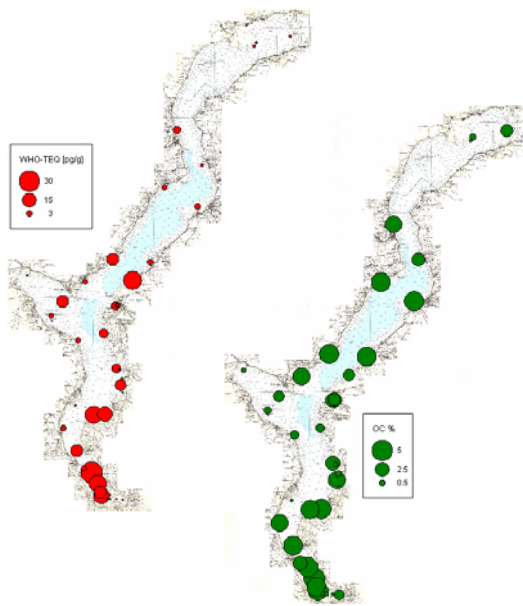


Figure 1: PCDD/Fs in LM sediments in pg WHO TEQ g-1 d.w. and Organic Carbon (OC) content in %

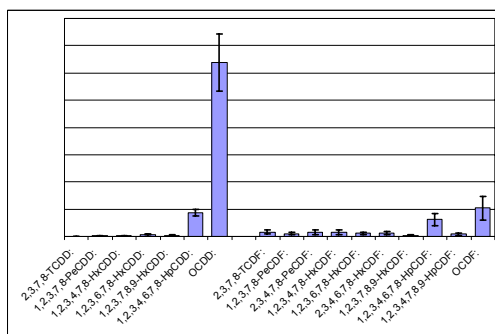


Figure 2: PCDD/F congener pattern in the LM sediments (average % ± SD)

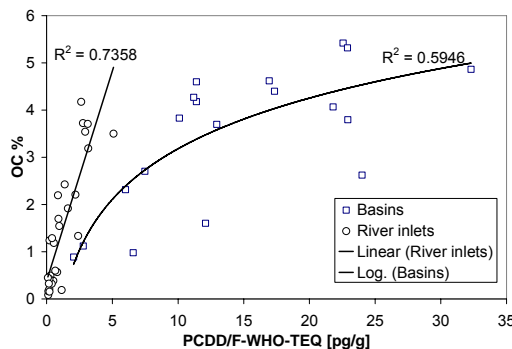


Figure 3: PCDD/Fs in the LM sediments in pg WHO TEQ g-1 d.w. versus Organic Carbon content (OC) in %

Results and Discussion

The PCDD/F concentration in the 50 surficial sediment samples taken at water depths between 5 and 60 m in LM ranged from 0.13 to 32 pg WHO TEQ g-1 d.w. (see Figure 1). The spatial homogeneity of the pattern along the whole lake (Figure 2) underlines the absence of local sources and important riverine inputs into LM. Moreover, the pattern is similar to that of PCDD/Fs in atmospheric particulate matter and bulk deposition collected locally from LM³, and is typical for atmospheric long range transport.

The spatial distribution of the PCDD/Fs (Figure 1) shows two principal tendencies. First, a north/south gradient of the PCDD/F concentrations probably deriving from the flushing of sediment from the north to the south due to intermittent resuspension in the shallower north basin. Second, sediments close to incoming rivers show lower concentrations than sediments in settling basins where no direct riverine discharges occur. At the southern outlet (River Ticino) of LM the PCDD/F concentrations decrease considerably compared to the southern section of the lake. This indicates that the settling conditions for particulate organic carbon (OC), the dominant transport vehicle for lipophilic compounds like PCDD/Fs in aquatic systems, are an important parameter for the PCDD/F burden in sediments. Consequently, lower concentrations of PCDD/Fs occur in the sediments close to river in and outlets, where turbulences inhibit the settling of OC.

The spatial distribution of the total OC content in the sediments (Figure 1) reflects the concentration distribution of the PCDD/Fs to some extent, however, not as pronounced as seen for PCDD/Fs. Only part of the spatial variations of PCDD/Fs in LM sediments can be explained by variations in total OC content of the sediments: The normalization of the PCDD/F concentration on the OC content of the sediments reduces the spatial variations from a factor of 246 (d.w. basis) to a factor of 85 (OC weight basis).

This observation is supported by the plot of total sedimentary OC versus PCDD/Fs concentrations for all sediments (Figure 3). Separating the concentrations observed in river inlet sediments from the settling basin sediments shows two distinct patterns: First, PCDD/Fs and OC in sediments close to the river inlets "○" show a linear relationship and a tendency of lower PCDD/F concentrations on an OC basis. Second, PCDD/Fs and OC in sediments from the basins "□" show a logarithmic relationship and OC based PCDD/F concentrations are considerably higher. This suggests that PCDD/F levels close to the river inlets are mainly determined by the settling of fresh OC as a local trap of contaminants. However, in the basins where organic matter rich in contaminants is continuously settling, decomposition of organic matter leads to a reduction of OC, while the more persistent PCDD/Fs are preserved in the sediments. This results in a higher PCDD/F load per unit TOC in the aged sediments of the LM basins.

References

- Binelli A, Ricciari, F, Proviini A. *Chemosphere* 2004; 7: 27-34
- Galassi S, Saino N, Melone G, Croce V. *Ecotox Environ Safe* 2002; 53: 163-169
- Castro-Jiménez J, Mariani, G, Umlauf G, Hanke G, Christoph E., Skejo H, Canuti E., Eisenreich SJ. *Organohalogen Compd* 2005; 67: 1209-1215

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