Polychlorinated-p-dioxins (PCDDs) and Dibenzofurans (PCDFs) in Bottom Sediments of the River Elbe

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PCDD/F contaminations originating from sources at the river Elbe upstream of Hamburg were supposed to contribute significantly to the PCDD/PCDF burden of the sediments in the harbour of Hamburg (1). In order to investigate this question, in the river Elbe bottom sediments and fresh sediments collected in sedimentation chambers up- and downstream of Hamburg (Figure 1) were sampled and analyzed.

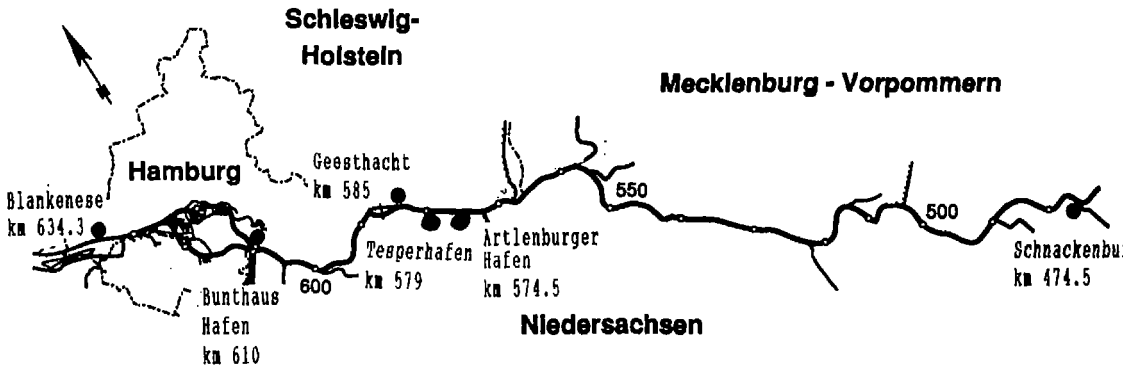

Fig. 1: River Elbe with locations of sediment sampling and stream kilometers

Six samples were taken upstream of the harbour of Hamburg (Schnackenburg to Bunthaus), two downstream of the harbour at Blankenese; further information on the samples is given in tab. 1. The sediments were analyzed for PCDDs and PCDFs. For sample characterization additionally grain size fractions, organic carbon, hydrocarbons, chlorinated benzenes, and adsorbed organically bound halogens (AOX) were determined.

Analysis

The centrifugated sample was mixed homogeneously with a fourfold amount of dehydrated sodium sulfate. The homogenisate was spiked with internal 13-C-UL standards (for each of the congener groups at least one standard except for OCDF) and extracted with toluene (Soxhlet). The extensive clean up was performed on a multicolumn system: 1. silicagel/potassium silicate/H_2SO_4-silicagel, 2. carbon on glass fibre, 3. cesium silicate/H2SO_4-silicagel, 4. alumina. The subsequent measurements were carried out by means of GC/MS involving a 60 m SP 2330 glass capillary column and a 30 m DB5 fused silica column coupled with a VG 7035 mass spectrometer. The quantification was effected by comparison with an external standards mixture and corrected with regard to the recoveries of the internal standards. The quality of the data was ensured by regular control of resolution, performance and sensitivity of the instruments as well as regular checks for instrument blanks and method blanks within each series of 4 samples.

Results and Discussion

In the 6 sediment samples (upstream) the concentrations for total PCDDs/Fs (Cl4-Cl8) varied between 15 370 and 27 860 pg/g and for the international toxic equivalents (TEQ) between 108 and 167 pg/g (tab.1). PCDD/F sediment data of Hamburg harbour (1) suggest that the river Elbe contributes significantly to the contamination of the Hamburg harbour. Normalized to organic carbon content of the sediment, the PCDD/F contamination of Elbe sediment is comparable to that of the river Rhine (2). The PCDD/F concentrations in the river Elbe were found to be 15-28 times higher than the Hamburg background level, measured in small surface waters at the outskirts of Hamburg.

From the pattern of the HpCDFs it is concluded that the PCDDs/Fs present in the sediments of the river Elbe not only originate from combustion emissions but also from noncombustion sources (chemical emissions of municipal, commercial, and industrial effluents).

In the two sediments sampled at Blankenese (downstream) concentrations of total PCDDs/Fs are 2530 and 2590 pg/g and for TEQ 31 and 28 pg/g. A possible explanation for lower sediment concentrations at Blankenese is dilution of more contaminated limnic with less contaminated marine sediments ("tidal pumping").

References

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Tab. 1: PCDD and PCDF in sediments of the River Elbe (pg/g d.w.)

sampling-site	Schnacken-burg	Schnacken-burg	Artlen-burger H.	Tesper-hafen	Geesthacht north bank	Bunthaus Hafen	Blankenese	Blankenese
	km 474.5	km 474.5	km 574.5	km 579	km 585	km 610	km 634.3	km 634.3
sampling-date	1.9.-4.10.89	4.10.-1.11.89	31.10.89	31.10.89	4.1.90	8.1.90	31.8.-2.10.89	2.10.-31.10.89
sample type	fresh sedim. sed. chamber	fresh sedim. sed. chamber	bottom sediment	bottom sediment	bottom sediment	bottom sediment	fresh sedim. sed. chamber	fresh sedim. sed. chamber
2378 TCDD	2	6	1	4	n.d.(1)	n.d.(1)	1	n.d.(1)
total TCDD	130	220	130	270	140	120	5	30
12378 PeCDD	n.d.(1)	n.d.(1)	10	n.d.(1)	2	6	n.d.(1)	n.d.(1)
total PeCDD	30	50	70	100	20	20	20	10
123478 HxCDD	10	10	4	3	7	2	2	5
123678 HxCDD	40	40	30	40	30	20	2	7
123789 HxCDD	50	40	40	8	20	20	3	10
total HxCDD	260	250	210	210	170	130	30	60
1234678 HpCDD	670	710	740	900	1500	1550	30	70
total HpCDD	1100	1110	1160	1410	2760	2670	70	130
OCDD	3200	4940	3160	4660	7970	8540	340	340
2378 TCDF	90	100	100	90	80	50	30	20
total TCDF	1560	1420	1940	1820	2160	1190	550	420
12378(+12348) PnCDF	110	90	210	140	150	80	50	40
23478 PnCDF	20	10	90	30	20	10	5	5
total PnCDF	590	560	1780	740	1730	750	260	160
123478(+123479)HxCDF	200	180	310	300	320	270	50	50
123678 HxCDF	200	100	230	260	260	290	40	60
123789 HxCDF	10	7	10	20	8	10	2	3
234678 HxCDF	20	30	30	30	8	30	4	4
total HxCDF	1220	1660	1800	1680	1880	1880	220	280
1234678 HpCDF	1150	2500	1480	2760	1400	1380	210	250
1234789 HpCDF	200	130	220	260	60	50	40	30
total HpCDF	2340	5200	2750	5910	2510	3750	340	370
OCDF	4920	11980	2580	11030	8520	7020	630	780
total PCDD	4720	6590	4740	6790	11060	11480	520	570
total PCDF	10650	20820	10850	21060	16800	13300	2010	2020
total PCDD/F	15370	27410	15590	27850	27860	24780	2530	2590
German TEQ	134	155	188	193	191	161	34	33
Intern. TEQ	108	117	167	156	138	127	31	28