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CORRELATION BETWEEN THE FLOOD LEVEL OF THE RIVER ELBE (GERMANY) AND THE PCDD/F CONCENTRATION OF THE TRANSPORTED SOLID MATTER

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Introduction

In summer 2002, a flood catastrophe in Central Europe by which especially the river Elbe in Germany and the Czech Republic was affected, caused huge amounts of sludge and sediment to be stirred up and transported down the river into the North Sea. The transported solids contained – among others- Persistent Organic Pollutants (POPs) like Polychlorinated Dibenzo-p-dioxins and furans (PCDD/PCDF) from the river bottom and the adjoining countryside. The possible sources of the PCDD/PCDF are presumably the well known old neglected deposits from industrial sites near the river or its tributaries. Especially to be mentioned are the industrial complexes of Spolana (CZ), and of the region around Bitterfeld (GER). From here, solids from highly contaminated soils were transported into the Elbe via its tributary Mulde[1], which was also flooded in August 2002. By way of the river Mulde, the main PCDD/PCDF load is transported into the Elbe [2,3].

Methods and Materials

Six samples of suspended solid matter from the river Elbe have been collected downstream of the Mulde estuary at Magdeburg in Saxony-Anhalt (river km 325.5; fig.1) on each day during the flood maximum between August 16 and August 20, 2002.

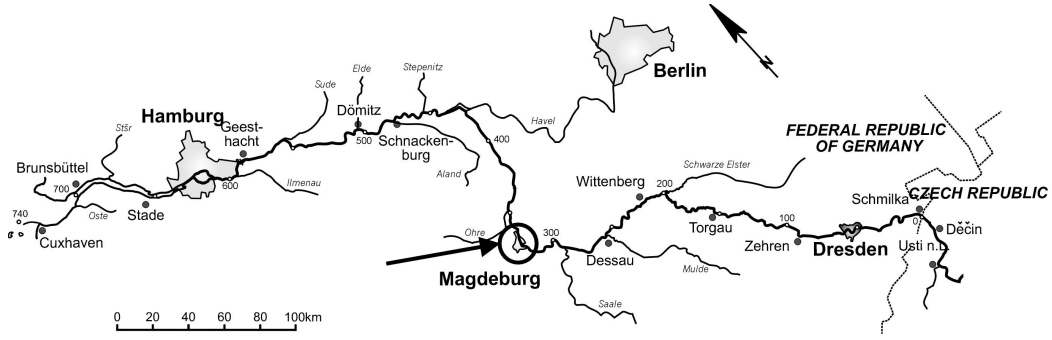

figure 1. the river Elbe from the Czech/German border to its estuary

The samples have been collected by the German Federal Institute of Hydrology (*BfG*). The sampling has been performed using a mobile flow-through centrifuge of the type Z61, Padberg (cf. fig. 2). The centrifuge has a separation rate of app. 95 – 98%. It was operated app. six hours each day at 17, 000 rpm with a throughput of 600-800 l/h. The concentrations of suspended solids varied between 20 and 80 mg/l, with the higher values under increasing discharge conditions.

figure 2.
sampling with the flow-through centrifuge at Magdeburg

The analysis of PCDD/F in the samples referred to here took place in the MPU laboratory in Berlin. They have been analysed using the German method DIN 38414-24 [4]. The extraction has been a Soxhlet extraction using toluene. The clean-up procedure and fractionation of the crude extract was carried out by adsorption chromatography as a multi-step-clean-up with e.g. silicagel columns and alumina columns. The cleaned extracts were analysed by HRGC/HRMS (R=10000) on a Micromass Autospec Ultima mass spectrometer. The water levels of the river Elbe have been taken from www.wetteronline.de/pegel/pegelkarte.htm.

Results and Discussion

The PCDD/F-levels of the suspended solids increased with the water level of the Elbe from 52ng I-TEQ/kg dry matter on August 16, 2002 to 85ng I-TEQ/kg dry matter on August 19, 2002. From this level, the contents slowly decreased together with the water level down to 41ng I-TEQ/kg dry matter on August 29, 2002 (cf. fig. 3). The total PCDD/F-contents are comparable with reference values found at Magdeburg in suspended solids (51ng I-TEQ/kg dry matter) and sediments (80ng I-TEQ/kg dry matter) in 1998 and 2000, respectively.[5] The correlation between the maximum content of PCDD/F in the transported solids and the flood level is demonstrated by fig.3.

From the positive correlation of the PCDD/F-concentration and the water level a diffuse input pattern can be concluded. Most probably, older, more consolidated sediments which would not have been mobilised under normal discharge conditions as well as contaminated soils from the flooding areas were the sources. The released particles are fine enough to be transported over far distances and just these fine particles are carrying the main PCDD/F load down the river Elbe without being deposited again to a greater extent.

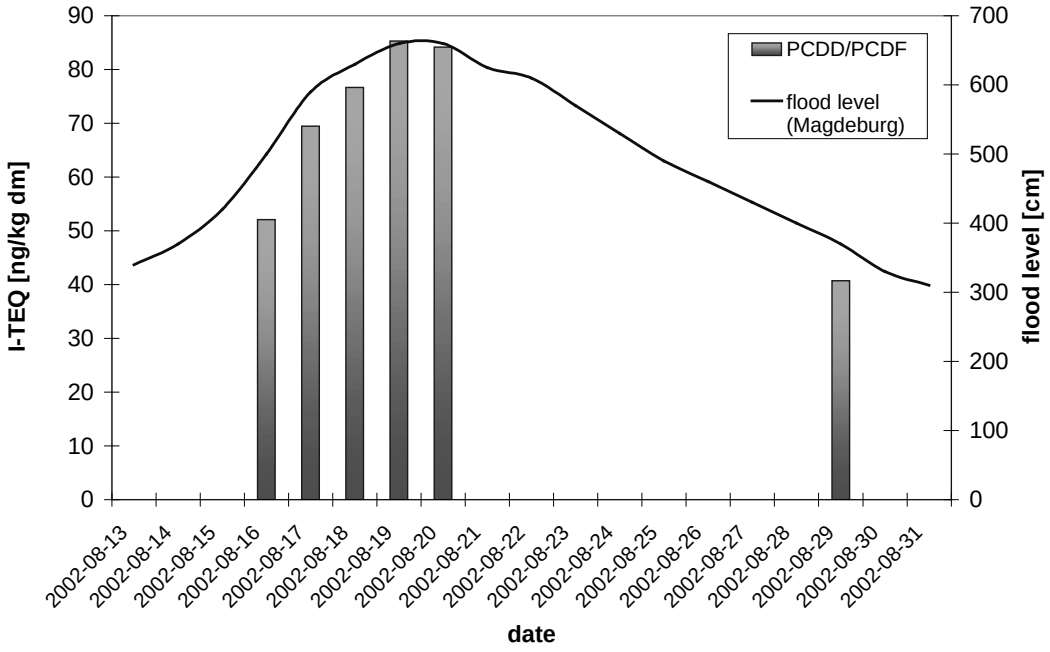

figure 3. PCDD/F in suspended solids vs. water level

According to the progress of the flood, two potential sources for an additional input of PCDD/F are to be considered. They are the above mentioned industrial areas of Spolana at the Upper Elbe (Czech Republic) and of Bitterfeld in the Mulde region (Germany). During the flood, the sampling site Magdeburg was much more influenced by the extreme discharges of the tributary Mulde than it would have been under normal conditions. This can be concluded from the significantly increased concentrations of a number of pollutants typical for the Mulde like As, Pb, and HCHs in suspended solids collected during the flood[6]. The same can be said for PCDD/F. Typically, in the Mulde region PCDD/F patterns occur which are dominated by furans, especially OCDF, and additionally by OCDD[7]. In contrast to the Mulde-pattern that of the Upper Elbe is dominated by the dioxins, especially the OCDD, while the furans with a portion of about 20% of the total PCDD/F-concentration play a minor role[7].

In the time between August 17 and August 20, 2002 the PCDF, especially HeptaCDF and OctaCDF, are clearly dominating the congener pattern whereas before and after the flood maximum the relative contribution of the PCDD, especially OctaCDD, is stronger (Fig.4). An influence of the additional contamination can be seen in the changed distribution of congener groups which occurred during the highest water level.

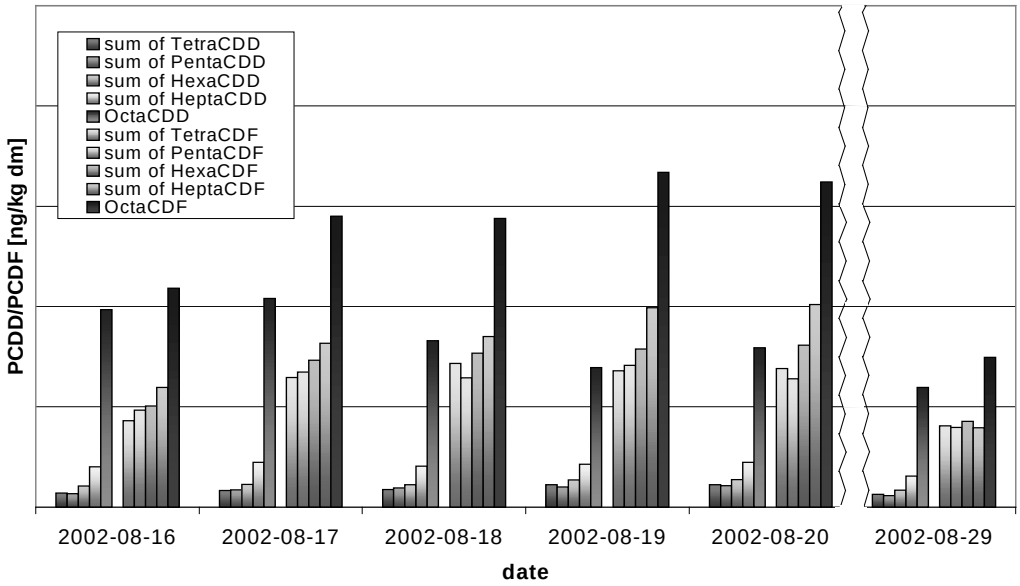

figure 4. PCDD/F congener groups

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