

CONTENTS OF PCDD/F IN SOIL AND ATMOSPHERIC DEPOSITION IN AN AGRICULTURAL AREA OF AN URBAN REGION (HAMBURG, FRG)

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Introduction

In an agricultural area in the south-east of Hamburg, adjacent to an industrial area, PCDD/F contents in soil and atmospheric deposition as well as in locally grown vegetables and in locally raised animals were measured. These investigations were prompted by the current discussion in Germany on the possible introduction of threshold values for PCDD/F in soil and atmospheric deposition. (Results of food analyses see Symposium contribution of Kühn, T. and Steeg, E.). The results of the entire investigation were to elucidate to what extent the PCDD/F contamination of soil and atmospheric deposition contributes to the PCDD/F contents of food, especially vegetables.

Methods

Samples for analysis were taken at 62 sampling sites which were used as cultivated land, grassland and allotment gardens. At each site 10 to 20 individual samples from zero to a maximum of 15 cm depth were mixed, to get a representative sample for analysis. Each soil sample was fractionated using a 2 mm sieve and the fraction < 2 mm was analysed. At five of these soil sampling sites the atmospheric deposition was measured by analysing 6 samples, each representing an exposure time of 2 months, in order to determine the annual mean.

Results and Discussion

The PCDD/F contents in all soil samples range from 1.7 to 684 ng/kg I-TEq (Tab. 1) with a median of 18 ng/kg I-TEq. Elevated soil levels were observed in the vicinity of a former chemical plant (up to 159 ng/kg I-TEq in the so-called "Moorfleeter Wanne") and along the banks of tributaries of the river Elbe (up to 684 ng/kg I-TEq), where until the fifties the land was regularly flooded during winter time. The latter contamination displays a very characteristic congener profile with PCDF exceeding PCDD by far (Tab. 1).

Tab. 1: Contents of PCDD/F in soil samples from the south-east of Hamburg.

| | All samples (n = 62) | | | Areas inland the dike (n = 47) | | | Dike foreshore (n = 15) | | |
|---------------------------|-------------------------|-------------------|------------------|-----------------------------------|-------------------|------------------|----------------------------|-------------------|------------------|
| | PCDDs* [ng/kg] | PCDFs* [ng/kg] | I-TEq [ng/kg] | PCDDs* [ng/kg] | PCDFs* [ng/kg] | I-TEq [ng/kg] | PCDDs* [ng/kg] | PCDFs* [ng/kg] | I-TEq [ng/kg] |
| Mean | 1534 | 2659 | 55 | 1746 | 962 | 29 | 869 | 7979 | 139 |
| Standard-deviation | 2008 | 6753 | 114 | 2208 | 846 | 31 | 962 | 12503 | 210 |
| Minimum | 243 | 62 | 2 | 243 | 62 | 2 | 264 | 163 | 3 |
| Maximum | 11559 | 42752 | 684 | 11559 | 4073 | 159 | 3997 | 42752 | 684 |
| Median | 739 | 822 | 18 | 820 | 687 | 18 | 486 | 1810 | 38 |
| 75-percentile | 1855 | 1487 | 49 | 2231 | 1333 | 39 | 1232 | 11039 | 199 |
| 90-percentile | 3637 | 3780 | 147 | 3795 | 2183 | 58 | 2553 | 34081 | 600 |
| 95-percentile | 3990 | 15664 | 227 | 7521 | 2974 | 112 | 3997 | 42752 | 684 |

Contents below the detection limit were not taken into account.

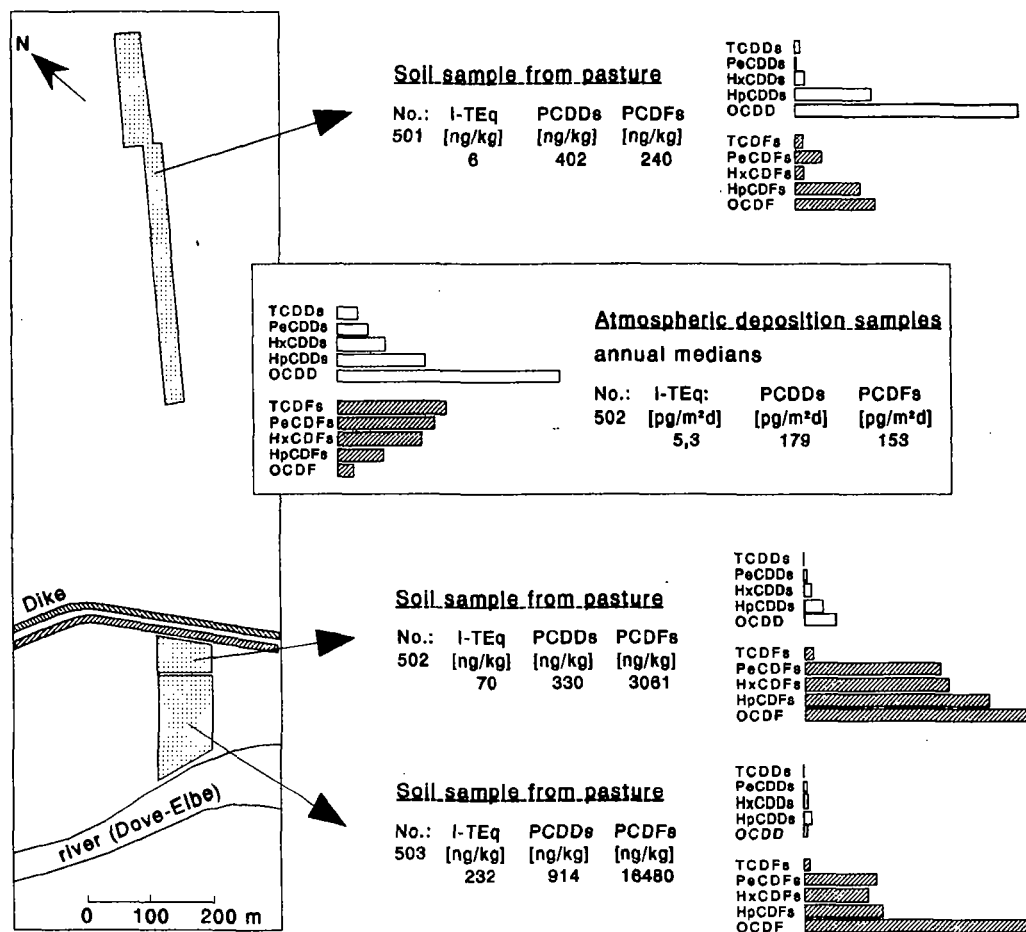
*: Total PCDDs respectively PCDFs (tetra through octa)

Tab. 2: Contents of PCDD/F in atmospheric deposition from five sampling sites in the south-east of Hamburg.

| Exposure time | Sampling sites | | | | |
|------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|
| | 101 | 201 | 401 | 502 | 621 |
| | I-TEq [pg/m ² d] | I-TEq [pg/m ² d] | I-TEq [pg/m ² d] | I-TEq [pg/m ² d] | I-TEq [pg/m ² d] |
| 12.10. - 12.12.90 | 25,6 | 15,3 | 7,6 | 17,9 | 2,1 |
| 12.12. - 12.02.91 | 11,5 | 9,3 | 5,0 | 3,3 | 2,2 |
| 12.02. - 12.04.91 | 13,9 | 10,1 | 4,0 | 2,7 | 3,0 |
| 12.04. - 12.06.91 | 12,7 | 12,9 | 11,9 | 5,9 | 3,5 |
| 14.06. - 13.08.91 | 6,4 | 6,7 | 108,3 | 4,6 | 2,3 |
| 13.08. - 15.10.91 | 7,3 | 66,1 | 2,8 | 6,2 | 3,7 |
| Annual mean % | 12,9 | 20,1 | 23,3 | 6,8 | 2,8 |
| Annual median % | 12,1 | 11,5 | 6,3 | 5,3 | 2,7 |

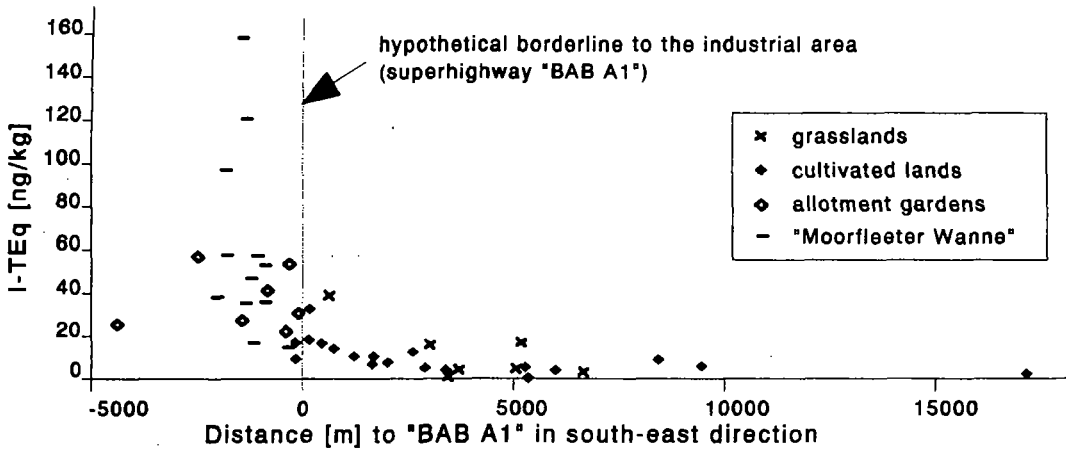
For a selected sampling site figure 1 illustrates this phenomenon in more detail. The area inland of the dike (grassland 501) exhibits a low PCDD/F content (6 ng/kg I-TEq) and a pattern where PCDDs are dominating, while in the areas in front of the dike (grassland 502 and 503) high values for PCDD/Fs were found (70 and 232 ng/kg I-TEq respectively) caused predominantly by high PCDF values.

Fig. 1: PCDD/F contents and patterns of neighbouring soils and local atmospheric deposition.



Atmospheric deposition as source of the high contamination of the dike foreshore is very unlikely because of the extremely different PCDD/F contents and patterns on sampling sites only a few hundred meters apart. More likely the contamination was caused by former floodings or deposition of sediment. Furthermore, the PCDD/F pattern of the atmospheric deposition at sampling site 502 shows little similarity to the PCDD/F profile of the soil sample 502 which is dominated by PCDF. This supports the conclusion that the elevated PCDD/F contamination on the banks of tributaries of the river Elbe cannot be explained by atmospheric immissions.

Fig. 2: PCDD/F contents in soils from the south-east of Hamburg as a function of distance from industrial area.



In general, the PCDD/F contamination of soil (Fig. 2) decreases with increasing distance from the industrial area (dike foreshore omitted). Soil values believed to originate from the diffuse atmospheric input ranged from some 40 ng/kg I-TEq on the edge of the industrial area to some 5 ng/kg I-TEq in a predominantly rural area. Correspondingly the atmospheric deposition decreases from 12 to 3 pg/(m² d) I-TEq (Tab. 2). However, one should keep in mind that soil contents are not likely to represent actual deposition. Nevertheless the PCDD/F pattern in these soil samples and average deposition samples are quite similar, especially for PCDDs (see also Fig. 1, soil-sample 501 and deposition 502).

Comparing our results with those from other states of the FRG ^{1,2,3} it is important to notice that the background level at the conurbation Hamburg with up to some 20 ng/kg I-TEq is significantly higher than values in rural areas (~1 ng/kg I-TEq). The BLAG-DIOXINE (German federal working group for dioxin evaluation) recommends 40 ng/kg I-TEq as a value where the growth of vegetables for human consumption is thought to be uncritical ⁴. Although this limit for soil is exceeded at 18 sampling sites no correlating increased values were found in the corresponding vegetable samples.

References

- 1 Abschlußbericht zum Forschungs- und Untersuchungsvorhaben "Belastung der Umwelt mit Dioxinen", Institut für Organische Chemie der Universität Tübingen, 1987
- 2 NRW-Meßprogramm "Chloraromaten - Herkunft und Transfer" 1990, Abschlußbericht Juni 1991
- 3 Bericht zur Ermittlung der ubiquitären Grundbelastung von niedersächsischen Böden mit polychlorierten Biphenylen und polychlorierten Dibenzodioxinen/ Dibenzofuranen. Niedersächsisches Landesamt für Bodenforschung, Hannover, 1991
- 4 BMU, 2. Bericht der Bund/Länder-Arbeitsgruppe DIOXINE, 3.9.1992