

THE VOLGERMEERPOLDER REVISITED DIOXINS IN SEDIMENTS, TOPSOIL, AND EEL

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1. Introduction

The sanitary landfill located in the Volgermeerpolder, a grazing-land area just north of Amsterdam, appeared to be heavily contaminated with a variety of toxic compounds as a result of massive chemical waste dumpings in former years. The extent of the environmental contamination has been studied and reported repeatedly in the past.^{1,2,3)} Reviewing the previous research findings, the presence of 2,3,7,8-TCDD and related compounds was one of the most striking features. It could be demonstrated that rather high concentrations of dioxins were present in soil, sediments, fish, and wildlife³⁾. These research activities dated back to the early and mid nineteen eighties. Taking into account that only provisional remediation steps were taken, the hazard that toxic substances might still accumulate had to be envisaged. Especially eel, has to be considered of major importance in this respect. For that reason, specimens of eel were analyzed again for dioxin congeners in 1994. The results obtained were compared with the earlier findings. In order to check the accumulative potency of dioxins in the area for eel, also the sediments in the main drainage watershed were analyzed for the dioxin congeners.

2. Methods

Sediment and topsoil samples were thoroughly homogenized and kept in sealed glass jars at -25°C. Eel were caught, deviscerated and stored in a freezer at -25°C. All in all, 10 specimens of eel, 10 sediment samples and 5 topsoil samples were analyzed. The analytical procedure consisted of Soxhlet extraction with toluene, followed by column chromatographic clean-up on silicagel with H₂SO₄ and NaOH, respectively. Eel samples were first freeze-dried for 24 hours. All samples were spiked with a mixture of ¹³C-labelled PCDDs/PCDFs at the first clean-up stage. The labelled TCDD was used as an internal standard. Isomer identification and quantification was carried out employing a Carlo Erba HRG/LRMS gas-chromatograph/mass-spectrometer in the EI⁺-mode, fitted with software for the QMD 1000. Since the detection limits of a number of analyses varied strongly, concentrations in samples below the detection limit have been taken to be equal to fixed values which correspond to the lowest concentration detected in the samples of the same matrix. This may give rise to an underestimation of the concentrations involved.

3. Results

In table 1, a presentation is given of the dioxin concentrations found in sediments, topsoil, and eel. Sediments and topsoil concentrations are given in dry weight and eel concentrations in wet weight. The findings are also expressed as TEQ values which enables one (by adding up) to establish the total toxicity potential of the environmental samples analyzed. It should be pointed out that the concentrations given are average values.

TABLE 1. Average levels of PCDD- and PCDF-congeners in sediments, topsoil, and eel, from the Volgermeerpolder hazardous waste site.
Concentrations in ppt (pg/g) and as TEQ values (pg/g)

Congeners	TEF	Sediment		Topsoil		Eel	
		dry weight		dry weight		wet weight	
		pg/g	TEQ	pg/g	TEQ	pg/g	TEQ
2378-TCDD	1.0	347 ± 571	347	106 ± 75	106	47.5 ± 64.8	47.5
12378-PeCDD	0.5	206 ± 506	103	72 ± 89	36	0.1 ± 0.1	0.1
123478-HxCDD	0.1	133 ± 285	13	50 ± 28	5	3.3 ± 1.7	0.3
123678-HxCDD	0.1	480 ± 530	48	58 ± 37	6	3.3 ± 1.7	0.3
123789-HxCDD	0.1	293 ± 304	29	40 ± 41	4	0.1 ± 0.1	-
1234678-HpCDD	0.01	3880 ± 2761	39	700 ± 485	7	0.1 ± 0.1	-
OCDD	0.001	9122 ± 4446	9	9678 ± 10553	10	0.1 ± 0.1	-
Σ PCDD-TEQ pg/g			588		174		48.2
2378-TCDF	0.1	278 ± 445	28	70 ± 102	7	1.9 ± 1.9	0.2
12378-PeCDF	0.05	914 ± 1722	46	272 ± 333	14	0.2 ± 0.1	-
23478-PeCDF	0.5	6266 ± 11011	3133	2516 ± 4054	1258	81.4 ± 69.3	40.7
123478-HxCDF	0.1	5259 ± 9600	526	1650 ± 2679	165	13.4 ± 11.3	1.3
123678-HxCDF	0.1	24 ± 20	2	74 ± 121	7	13.4 ± 11.3	1.4
234678-HxCDF	0.1	35 ± 25	4	72 ± 97	7	0.1 ± 0.1	-
123789-HxCDF	0.1	10 ± 0	1	10 ± 0	1	1.2 ± 0.4	0.1
1234678-HpCDF	0.01	892 ± 835	9	1662 ± 2941	17	1.6 ± 1.1	-
1234789-HpCDF	0.01	100 ± 97	1	268 ± 533	3	0.2 ± 0.2	-
OCDF	0.001	2608 ± 3664	3	10684 ± 20644	11	1.0 ± 0.7	-
Σ PCDF-TEQ pg/g			3753		1490		43.7
Σ PCDD/F-TEQ pg/g			4341		1664		91.9

The magnitude of the standard deviations indicates that the variability between the separate samples of the same matrix is rather large, which is common in case of environmental monitoring.

The data indicate that the most toxic congener, i.e. 2,3,7,8-TCDD, can still be detected in eel, as was the case in the early eighties. Together with 2,3,4,7,8-PeCDF, the most toxic dibenzofuran congener, it accounts for nearly 100% of the total TEQ values (91.9) expressed in ppt (pg/g) wet weight. Since the Dutch ADI for dioxins is 600 pg for a person of 60 kg, it can be easily seen that consumption of those eel on a regular basis should still be discouraged. This conclusion is in good agreement with previous findings dating back to 1980-1985. Table 2 presents the data for 2,3,7,8-TCDD and 2,3,4,7,8-PeCDF found in topsoil, sediments and eel both in 1981/84 and 1994. The data are given as concentration ranges.

Both the topsoil and sediment samples were taken from about the same spots as in former years, allowing the results to be compared with the previous ones. For the same reason, eel were caught in the main watershed that drains the area.

TABLE 2. Concentrations of 2,3,7,8-TCDD and 2,3,4,7,8-PeCDF in topsoil, sediments, and eel from the Volgermeerpolder in 1981/84 and 1994

	Topsoil		Sediments		Eel	
	pg/g dry weight		pg/g dry weight		pg/g wet weight	
	TCDD	PeCDF	TCDD	PeCDF	TCDD	PeCDF
1981/84	<20-1929	<10-5650	844-3556	-	104-144	182-558
1994	40-210	150-971	10-1880	30-35100	4-187	5-196

As can be seen, the data on sediments and eel are of the same order of magnitude in both 1981/84 and 1994. Bioaccumulation of 2,3,7,8-TCDD and 2,3,4,7,8-PeCDF in eel is most probably due to the contaminated sediments in the main drainage canal of the dump site. The bioaccumulation factor expressed as wet weight of eel versus dry weight of sediments varies for TCDD between 0.04 and 0.12 in 1981/84, compared with 0.10 and 0.25 in 1994. For PeCDF this factor varies between 0.06 and 0.17 according to the data obtained in 1994 only. Although the levels observed in 1994 tend to be somewhat lower than in 1981/84, the data show that the extent of contamination of topsoil, sediments and eel at the Volgermeerpolder hazardous waste site has remained virtually unaltered. The differences found are most probably due to small differences in sampling site.

In figure 1, the bioaccumulation in eel for 2,3,7,8-TCDD; 2,3,7,8-TCDF; 2,3,4,7,8-PeCDF and 1,2,3,4,6,7,8-HxCDF found in 1994, has been expressed as biota-sediment accumulation factors (BSAFs), i.e. the ratio between the concentrations in eel as lipid weight and in sediments as organic matter, according to Van der Oost et al.⁴⁾ The graph clearly demonstrates that the BSAFs vary between 0.224 for TCDD and 0.0025 for HxCDF, i.e. 100 times lower for the less toxic congeners. These findings refer to 1994 only.

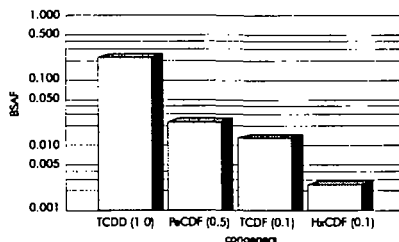


Figure 1: Eel-congeners sediment accumulation factors (BSAFs) of 2,3,7,8-TCDD; 2,3,7,8-TCDF; 2,3,4,7,8-PeCDF and 1,2,3,4,6,7,8-HxCDF in the Volgermeerpolder. TEFs in parantheses.

4. Discussion

The discovery of large amounts of hazardous waste chemicals on the sanitary landfill in the Volgermeerpolder in 1980 gave rise to severe public unrest. Residents living close to the site required an immediate stop of all sorts of waste dumpings and filed a claim demanding complete physical containment of the area. A joint group of key officials of local and provincial government, supported by an engineering consultant, submitted an advisory aimed at protecting the environment from any further contamination. Preliminary remedial actions were implemented in the years 1980-1982. These consisted, among others, of fencing-off the area and cancelling all dumping activities. A major intermediate step was the gathering, removal and subsequent storage of all chemical waste-containing drums which were present in the topsoil of the site. As a necessary follow-up, further and more drastic remedial action strategies were developed.^{5,6)} Since then, more than ten years have passed, without implementation of any of the final remedial action plans.

The recently obtained findings of dioxin congeners in topsoil and eel are of major importance for the evaluation of the efficacy of the remedial actions executed so far. The more or less equal concentrations found in 1981/84 and 1994 can be considered as sufficient proof that the extent of contamination with the most toxic waste compounds has remained rather constant, notwithstanding the execution of a number of provisional remediation measures.

5. Conclusion

A study aimed at the detection of dioxin congeners in sediments, topsoil and eel in the Volgermeerpolder hazardous waste site, after a ten-year research gap, revealed that these compounds are still present in the environmental compartments concerned. The concentrations of the most toxic dioxin congeners in topsoil and eel determined in 1994 fall within the same concentration range as found in 1981/84, indicating that the contaminant circumstances have remained basically unaltered. The dioxin concentrations found in eel, taken from within the enclosure, still justify the existing ban on eel consumption.

6. References

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