PCDD/PCDF Levels in Sediments from a River System in Southern Mississippi

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ABSTRACT

In 1994, we analyzed 61 sediment samples from a river system in southern Mississippi. The mean level in sediments was 10.60 ng I-TEQ/kg d.m. with a median value of 9.90 ng I-TEQ/kg d.m. Comparing these results with the median concentration from only the Leaf and Pacagoula Rivers of a 1992 sampling by state authorities, our concentrations were about three times higher. However, the median value as determined for the tributaries and drainage ditches in 1992 was very similar to our findings, although in their sampling potentially highly contaminated locations were targeted.

INTRODUCTION

Sediments are known sinks for waterborne, persistent and lipophilic substances such as polychlorinated dibenzo-*p*-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF).

In 1992, PCDD and PCDF concentrations from the Leaf and Pascagoula Rivers and some of their tributaries were reported by the Mississippi Department of Environmental Quality (DEQ) [1]. The levels found in the Leaf and Pascagoula Rivers were relatively consistent for the entire 100 miles sampled, ranging from 1.04 to 10.34 ng I-TEQ/kg d.m. The highest value - 9,232 ng I-TEQ/kg d.m. - was reported for a sediment sample in Mineral Creek, which flows into the Leaf River near Hattiesburg, MS. Finally, drainage ditches discharging into the Leaf River from a wood treatment facility in Beaumont exhibited a PCDD/PCDF homologue profile and isomeric pattern similar to commercial pentachlorophenol. This was proven with mathematical and statistical methods [2].

We analyzed a total of 61 sediment samples from eight rivers in southern Mississippi. Samples were taken from three major rivers: Leaf River (n = 11), Chickasawhay River (n = 8), and Pascagoula River (n = 7). In addition, five tributaries to the Leaf River were sampled: Bowie River (n = 4), Weldy Creek (n = 1), Tallahala Creek (n = 9), Bogue Homa Creek (n = 6) and Thompson Creek (n = 5). Finally, three tributaries to the Pascagoula River were sampled: Black Creek (n = 7), Big Creek (n = 1), and Big Cedar Creek (n = 2).

MATERIALS AND METHODS

Sediment samples were collected in July and August 1995. For a description of the sampling and analytical methods, see Ref. [3].

RESULTS

Table 1 reports the results for all 61 locations for 2,3,7,8-Cl_4DD, Σ(PCDD+PCDF), I-TEQ normalized to dry mass (d.m.) and to loss of ignition (LOI) in ng/kg. Detection limits for all non-detected 2,3,7,8-Cl_4DD are given in parentheses. Reporting concentrations based to organic carbon content (by determining the LOI) eliminates the effect that lipophilic compounds such as PCDD and PCDF adsorb and absorb more strongly to organic matter than to inorganic matrices.

2,3,7,8-Cl_4DD was not found at a detection limit of approximately 0.04 ng/kg d.m. in 7 of the 61 sediment samples. For 2,3,7,8-Cl_4DD, the highest concentration was 1.2 ng/kg d.m. at two sites in the Pascagoula River (samples SE801 and SE803).

Table 1: PCDD/PCDF concentrations in sediments from eight rivers and creeks in southern Mississippi (concentrations in ng/kg).

River/Creek	Sample	LOI (%)	2,3,7,8-Cl_4DD	Σ(PCDD+PCDF)	I-TEQ	I-TEQ (LOI)
Bowie River	SE111	2.17	0.097	2,490	3.63	167
	SE112	3.35	0.057	4,927	6.22	186
	SE113	3.42	0.13	5,316	7.29	213
	SE114	1.89	ND (0.023)	1,693	2.52	133
Tallahala Creek	SE201	2.07	0.20	8,100	10.40	503
	SE202	2.20	0.28	5,569	9.90	450
	SE203	0.86	ND (0.038)	1,145	3.99	466
	SE204	6.57	0.46	11,490	27.60	420
	SE205	1.92	0.22	7,720	11.90	619
	SE206	3.27	0.26	5,109	7.14	218
	SE207	3.52	0.29	10,259	15.90	452
	SE208	2.08	0.31	6,326	10.50	506
	SE209	4.92	0.37	13,923	20.00	407
Bogue Homa	SE301	11.25	0.27	27,649	33.30	296
Creek	SE302	4.41	0.069	6,460	8.19	186
	SE303	1.91	0.088	4,562	5.49	287
	SE304	5.02	0.17	6,005	7.16	143
	SE305	2.30	0.063	2,093	2.86	124
	SE306	1.06	ND (0.047)	1,661	2.15	203
Thompson	SE401	1.68	ND (0.023)	5,016	5.41	323
Creek	SE402	2.53	0.045	4,274	5.34	211
	SE403	3.35	ND (0.043)	3,397	5.11	152
	SE404	3.43	0.067	5,067	6.96	203
	SE405	2.14	0.065	5,654	7.19	335

Table 1 (continued)

River/Creek	Sample	LOI (%)	2,3,7,8-Cl_4DD	Σ(PCDD+PCDF)	I-TEQ	I-TEQ (LOI)
Leaf River	SE500	5.76	0.44	16,883	21.7	377
	SE501	2.83	0.31	85,000	11.6	410
	SE502	2.22	0.28	6,255	8.58	387
	SE503	3.28	0.73	7,969	12.2	372
	SE504	2.38	0.5	7,584	11.0	461
	SE505	3.08	0.36	5,538	9.96	323
	SE506	3.83	0.38	14,079	20.6	539
	SE507	2.45	0.27	4,624	7.87	320
	SE508	2.38	0.45	5,823	10.0	420
	SE509	2.11	0.15	5,128	8.39	398
	SE510	2.68	0.24	5,076	8.69	324
Black Creek	SE601	1.05	0.072	239	0.41	38.9
	SE602	4.68	0.072	1,071	1.73	36.9
	SE603	3.75	0.16	4,530	5.37	143
	SE604	3.12	ND (0.033)	1,920	2.71	87.8
	SE605	1.96	ND (0.035)	5,630	6.37	325
	SE606	2.28	0.18	8,221	12.2	535
	SE608	3.54	0.16	9,202	12.9	364
Chickasawhay	SE701	1.88	0.13	7,954	11.1	593
River	SE702	3.4	0.23	9,175	15.4	453
	SE703	2.86	0.69	10,838	17.1	597
	SE704	4.09	0.58	15,443	23.1	563
	SE705	3.41	0.46	6,706	10.5	308
	SE706	1.29	0.29	4,896	7.66	593
	SE707	2.54	0.47	9,610	14.2	560
	SE708	3.31	0.65	11,290	17.8	539
Pascagoula	SE801	2.85	1.2	4,968	11.1	389
River	SE802	4.59	0.81	7,316	15.7	343
	SE803	3.21	1.2	6,667	13.4	416
	SE804	3.96	0.46	4,473	8.23	208
	SE805	4.59	0.67	18,574	26.9	587
	SE806	1.73	0.41	7,088	10.5	608
	SE807	4.02	0.66	17,450	24.7	615
Big Creek	SE811	10.45	0.051	685	1.33	12.7
Big Cedar Cr.	SE812	8.98	0.35	6,811	9.95	111
	SE813	3.21	0.062	3,712	4.75	148
Weldy Creek	SE950	3.47	0.37	3,361	4.8	138
Mean			**0.30**	**8,323**	**10.6**	**342**
Median			**0.26**	**5,832**	**9.90**	**343**
Stand.dev.			**0.27**	**11,103**	**6.96**	**170**

As can be seen from Table 1, the mean and the median values for the I-TEQ are almost identical when normalized to LOI. Thus, there is a normal bell-shaped distribution of the PCDD/PCDF concentrations amongst all rivers and creeks sampled (minimum = 12.6 ng I-TEQ/kg for sample SE811, maximum = 615 ng I-TEQ/kg for SE807). Due to the variation in the organic carbon content of the samples (range of LOI: 0.86-11.25 %), the concentrations based on the dry mas content show a larger range of contamination (minimum concentration = 0.41 ng I-TEQ/kg d.m. for sample SE601, maximum = 33.5 ng I-TEQ/kg d.m.

for sample SE301). The highest concentration on dry mass basis was detected in sample SE301 and is more than three times the mean and median values of all samples as a result of the organic carbon content (LOI = 11.25 %). Normalized to LOI, this sample has a concentration below the mean and median values.

DISCUSSION

Table 2 summarizes the 22 DEQ Leaf and Pascagoula Rivers' sediment data [1] by reporting the mean and median values for 2,3,7,8-Cl_4DD, Σ(PCDD+PCDF), and I-TEQ in ng/kg d.m. Unlike our 1994 sampling, the 1992 DEQ data were not normalized to LOI.

Table 2: Summary of the 1992 DEQ Leaf and Pascagoula Rivers' sediment data. Number of samples = 22. All concentrations in ng/kg d.m.

	2,3,7,8-Cl_4DD	Σ(PCDD+PCDF)	I-TEQ
Mean	0.12	2,212	3.69
Median	0.00 *	2,019	2.98
Standard deviation	0.19	1,098	2.24

* 14 of the 22 samples had non-detectable concentrations of 2,3,7,8-Cl_4DD.

Generally, the mean and median values (dry mass) from our 1994 sampling gave higher PCDD/PCDF concentrations than in the 1992 DEQ sampling. However, as seen from Table 3, the 1992 DEQ sampling found very high concentrations of both 2,3,7,8-Cl_4DD and I-TEQ in the tributaries and the sediment of the drainage ditches [1]. The median value of these tributaries samples are in good agreement with the results from our 1994 study.

Table 3: Summary of the 1992 DEQ Leaf River tributaries and drainage ditches. Number of samples = 7. All concentrations in ng/kg d.m. [1].

	2,3,7,8-Cl_4DD	Σ(PCDD+PCDF)	I-TEQ
Mean	3.9	471,269	1341
Median	0.0 *	3,893	11
Standard deviation	9.2	1,228,977	3480

* 5 of the 7 samples had non-detectable concentrations of 2,3,7,8-Cl_4DD.

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