

7. Atmospheric Supply of PCDD/Fs to the Baltic Sea in 2005

In this chapter the results of model evaluation of dioxins and furans (PCDD/Fs) atmospheric input to the Baltic Sea and its sub-basins for 2005 is presented. Modelling of PCDD/F atmospheric transport and depositions was carried out using MSC-E Eulerian Persistent Organic Pollutant transport model MSCE-POP (Gusev et al., 2005). Latest available official information on PCDD/F emission from HELCOM countries and other European countries was used in computations. Based on these data levels of annual and monthly PCDD/F depositions to the Baltic Sea region have been obtained and contributions of HELCOM countries emission sources to the depositions over the Baltic Sea are estimated.

7.1 PCDD/Fs emissions

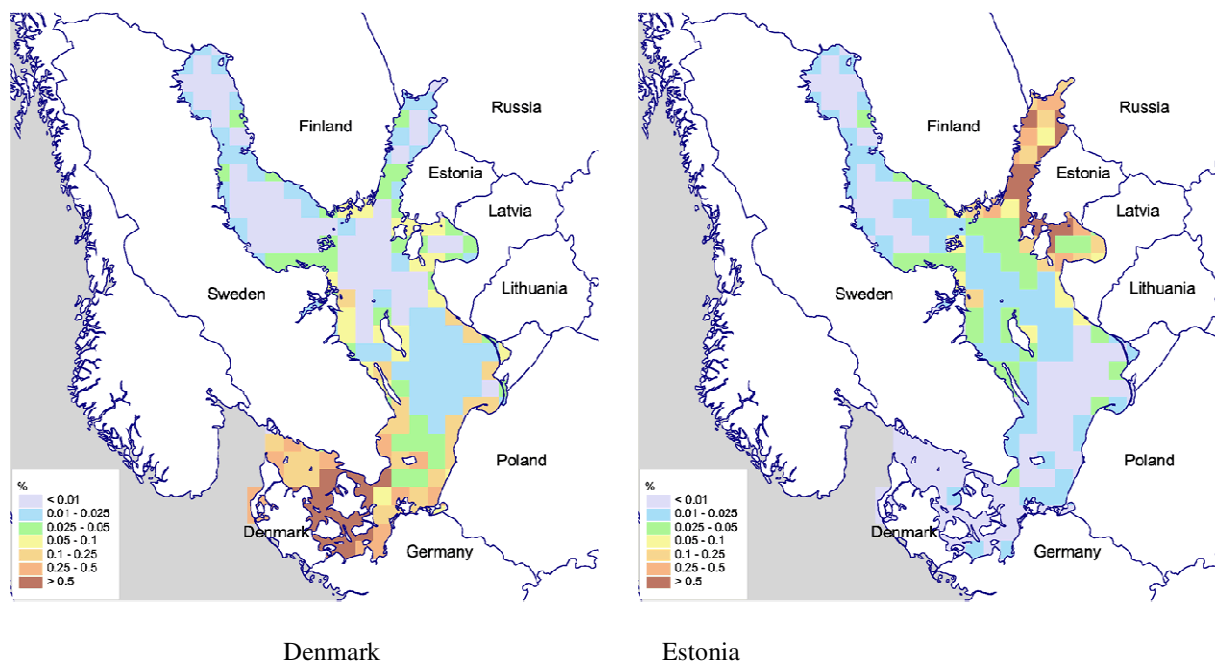


Figure 7.1. Maps with the fractions (in %) of annual total anthropogenic PCDD/F emissions from HELCOM Parties deposited over the Baltic Sea in 2005.

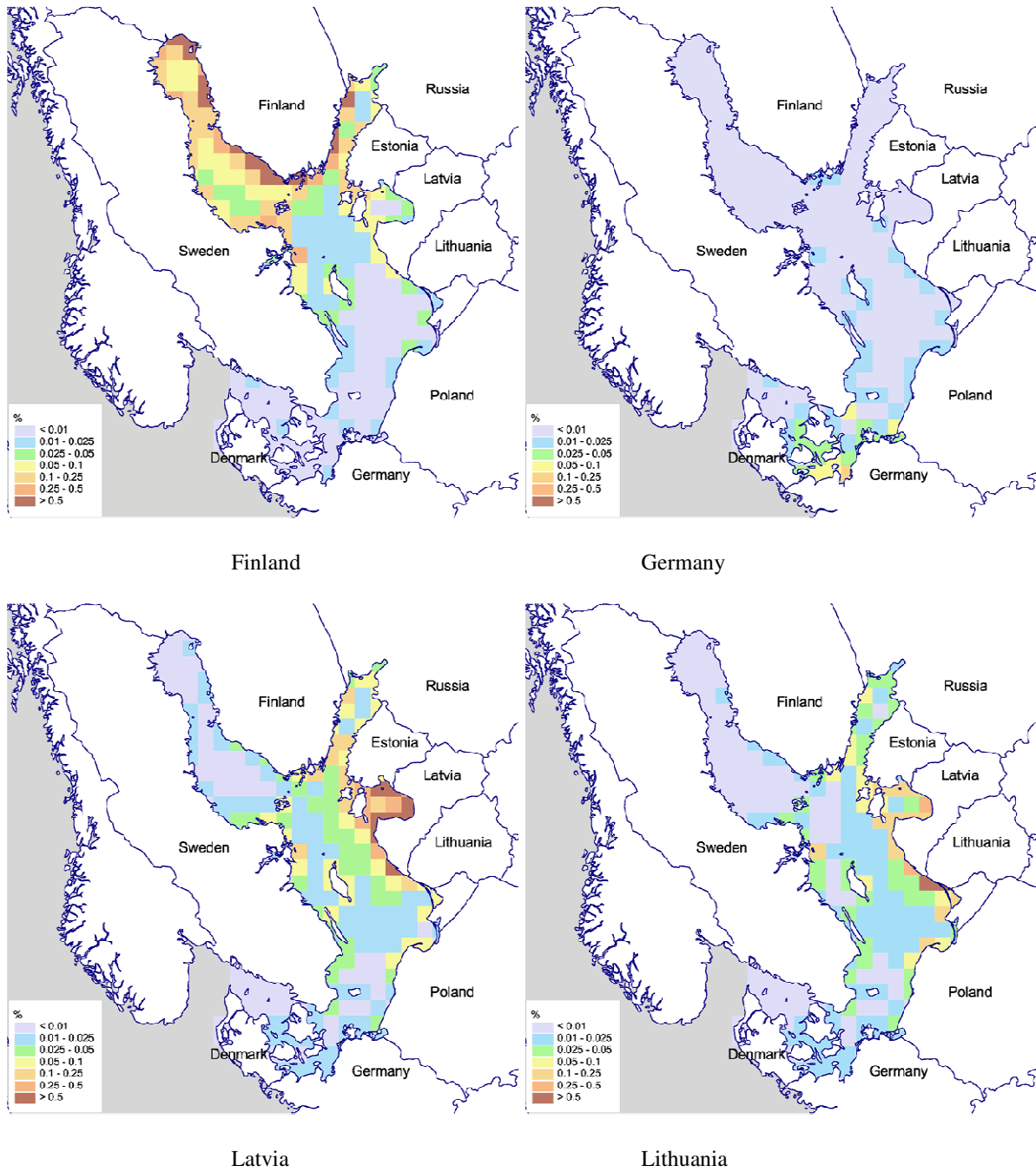


Figure 7.1 (cont.). Maps with the fractions (in %) of annual total anthropogenic PCDD/F emissions from HELCOM Parties deposited over the Baltic Sea in 2005.

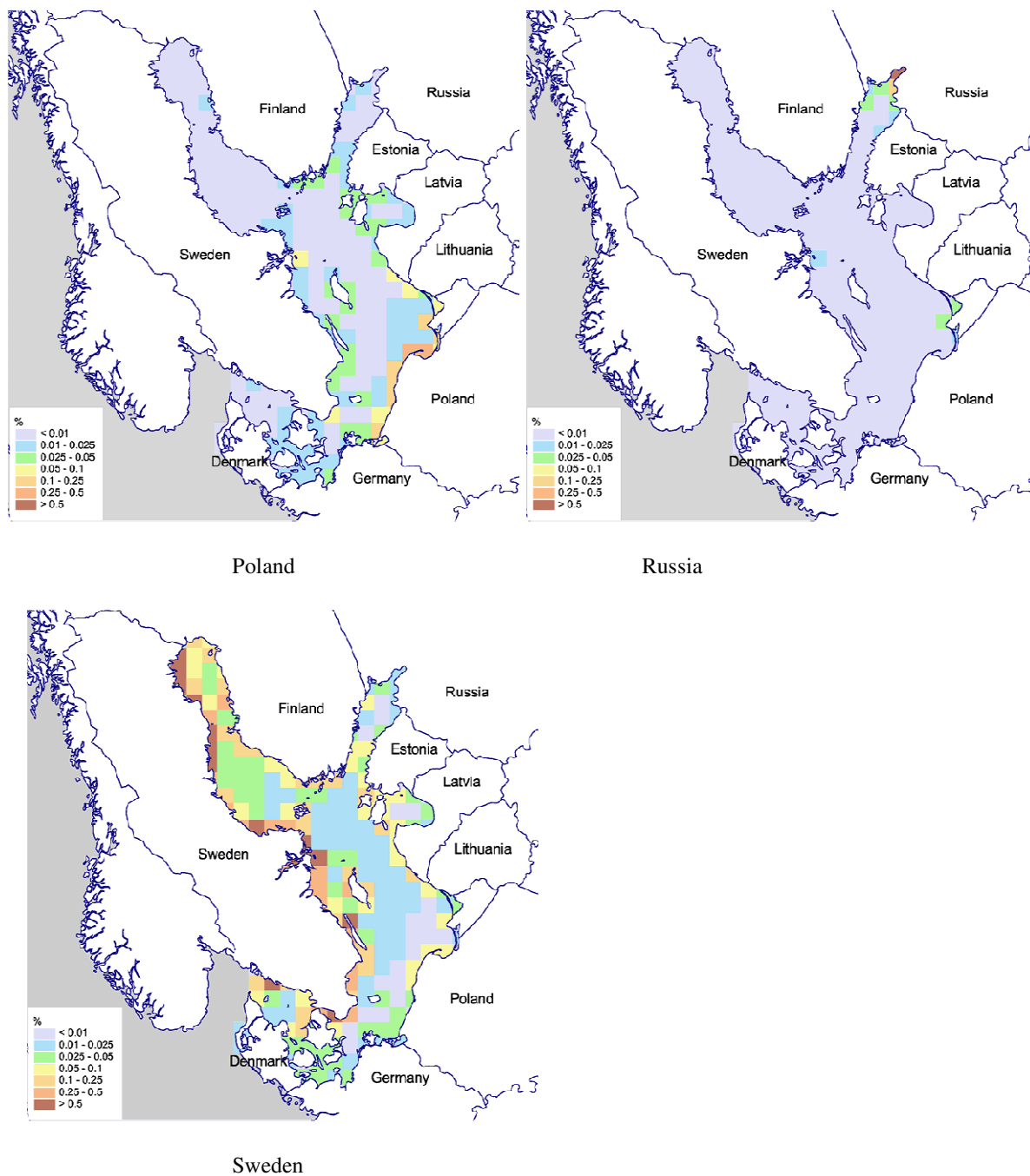


Figure 7.1 (cont.). Maps with the fractions (in %) of annual total anthropogenic PCDD/F emissions from HELCOM Parties deposited over the Baltic Sea in 2005.

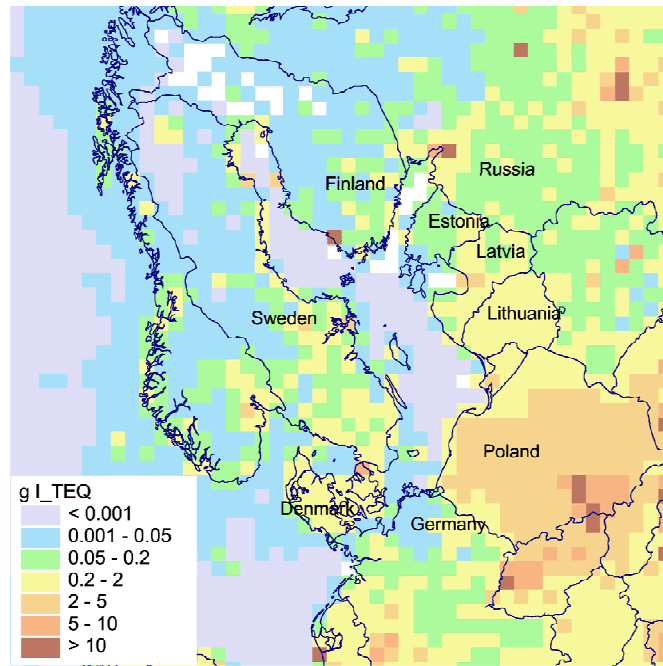


Figure 7.2. Annual total anthropogenic emissions of PCDD/F in the Baltic Sea region for 2005, g TEQ/y.

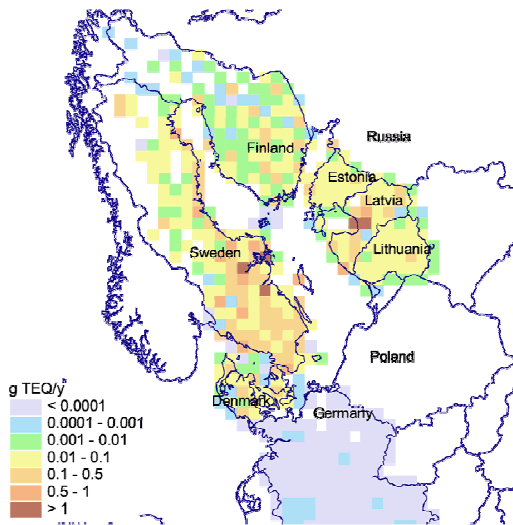


Figure 7.3. Annual PCDD/F emission of HELCOM countries from Combustion in Power Plants and Industry sector for 2005.

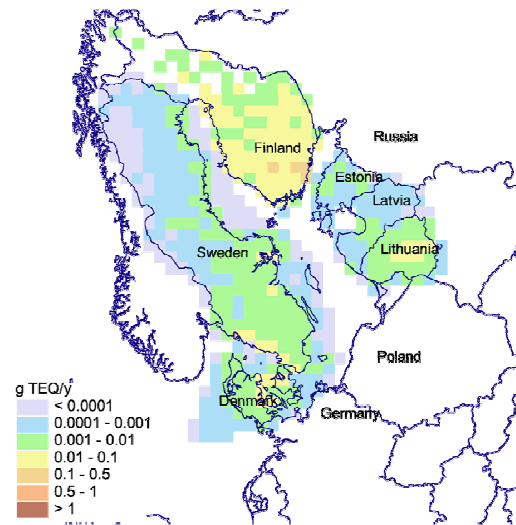


Figure 7.4. Annual PCDD/F emission of HELCOM countries from Transport sources below 1000 m sector for 2005.

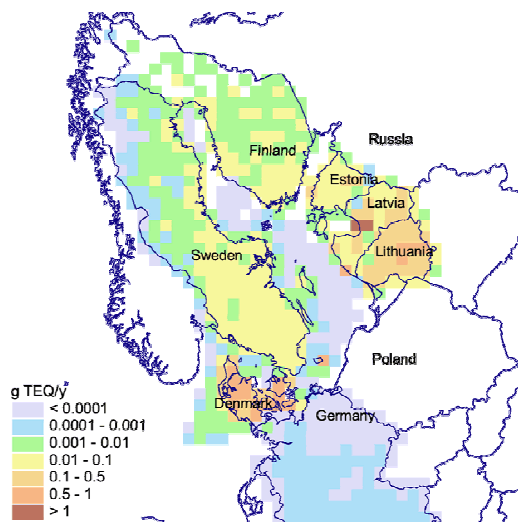


Figure 7.5. Annual PCDD/F emission of HELCOM countries from Commercial, Residential and Other Stationary Combustion sector for 2005.

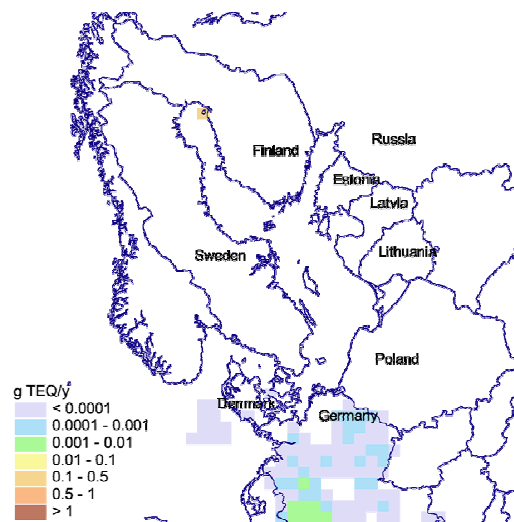


Figure 7.6. Annual PCDD/F emission of HELCOM countries from Fugitive Emissions From Fuels sector for 2005.

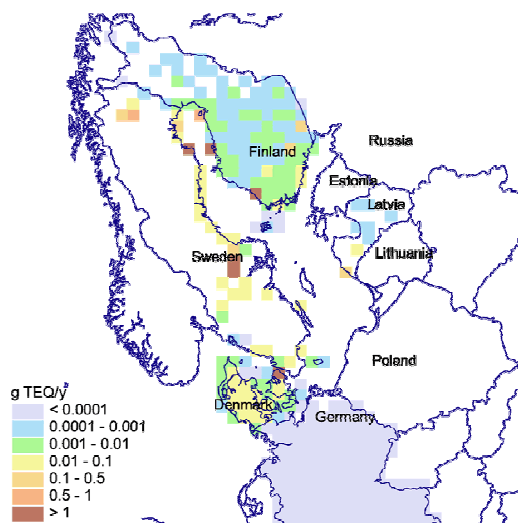


Figure 7.7. Annual PCDD/F emission of HELCOM countries from Industrial Processes sector for 2005

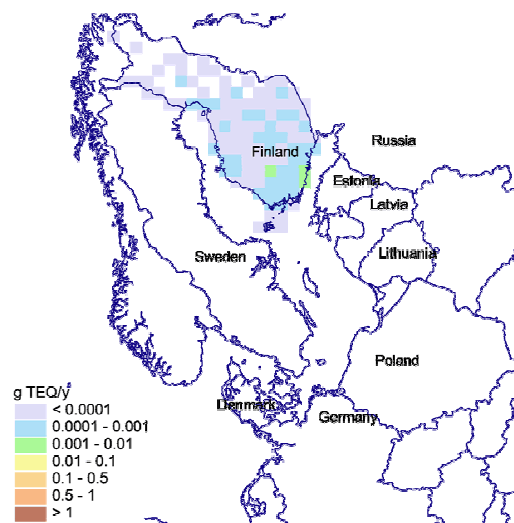


Figure 7.8. Annual PCDD/F emission of HELCOM countries from Solvent and Other Product Use sector for 2005.

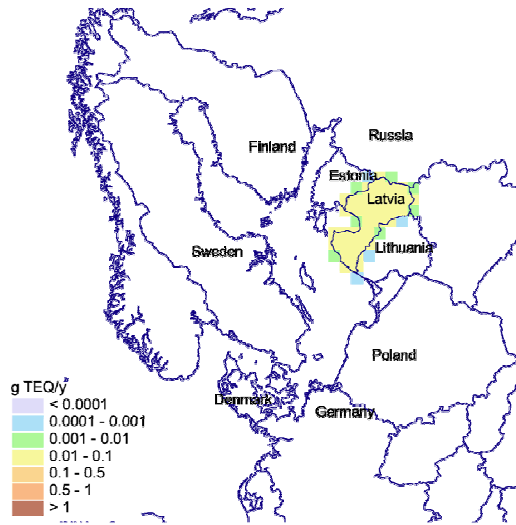


Figure 7.9. Annual PCDD/F emission of HELCOM countries from Agriculture sector for 2005

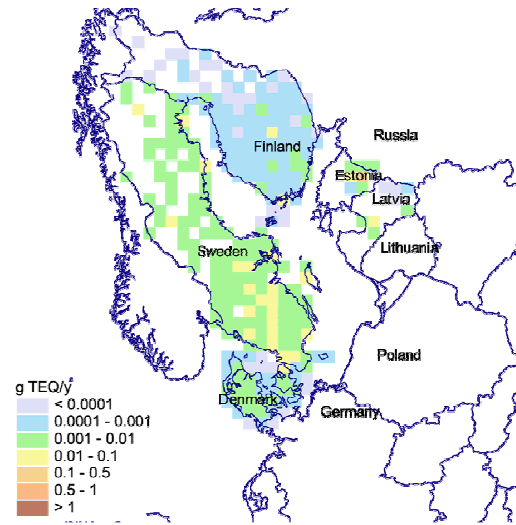


Figure 7.10. Annual PCDD/F emission of HELCOM countries from Waste sector for 2005.

Table 7.1. Annual total PCDD/F anthropogenic emissions of HELCOM countries from different sectors for 2005, in g TEQ per year

NFR emission sector	Sector name	DK	EE	FI	DE	LV	LT	PL	RU	SE
1	Combustion in Power Plants and Industry	2.4	1.2	17.2	0.01	10.04	1.4	40.9	655	25.4
2	Transport	0.3	0.05	2.7	NA	0.02	0.2	0.6		0.6
3	Commercial, Residential and Other Stationary Combustion	16.3	1.8	1.1	0.02	7.8	9.2	204.3		3.03
4	Fugitive Emissions From Fuels	< 0.01	NA	0.2	0.04	0	0	2.6		NE
5	Industrial Processes	6.3	0	4.9	< 0.01	0.3	0	12.3		8.5
6	Solvent and Other Product Use	0	0	0.02	NA	0	0	0		NA
7	Agriculture	0	NA	0	NA	1.05	0	0.7		NA
8	Waste	0.04	0.2	0.1	< 0.01	0.02	0	155.3		1.06
9	Other				NA					
Total		25.3	3.2	26.2	0.1	19.2	10.9	416.4	655	38.6

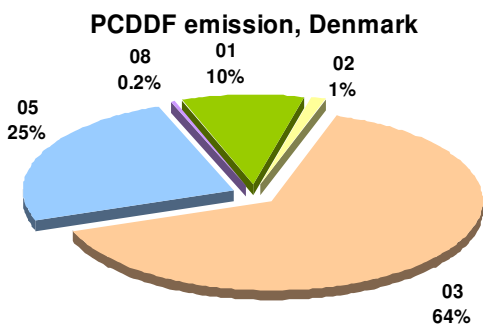


Figure 7.11. Percentage of annual total PCDD/F emission from different sectors in Denmark for 2005 5.1 7.01

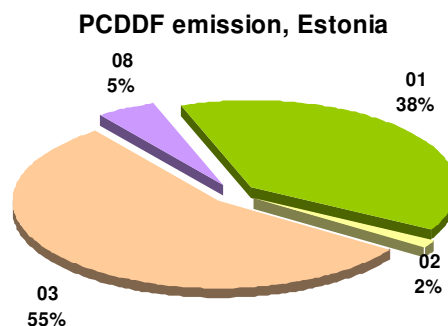


Figure 7.12. Percentage of annual total PCDD/F emission from different sectors in Estonia for 2005

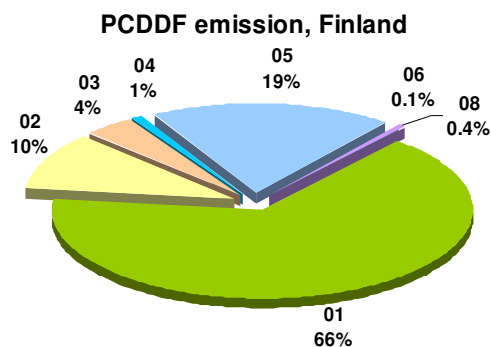


Figure 7.13. Percentage of annual total PCDD/F emission from different sectors in Finland for 2005

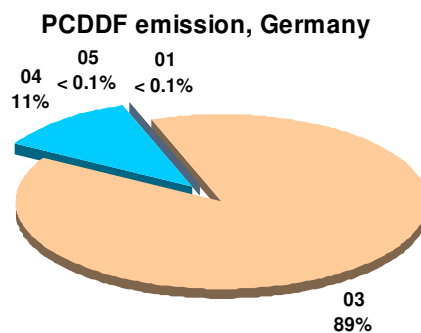


Figure 7.14. Percentage of annual total PCDD/F emission from different sectors in Germany for 2005

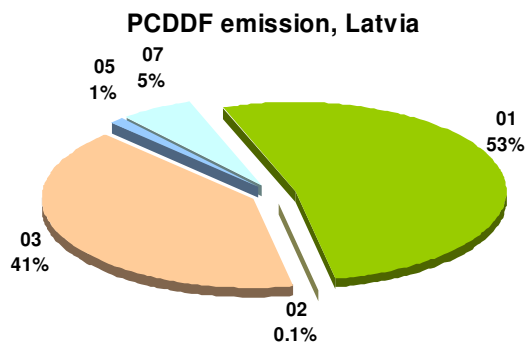


Figure 7.15. Percentage of annual total PCDD/F emission from different sectors in Latvia for 2005

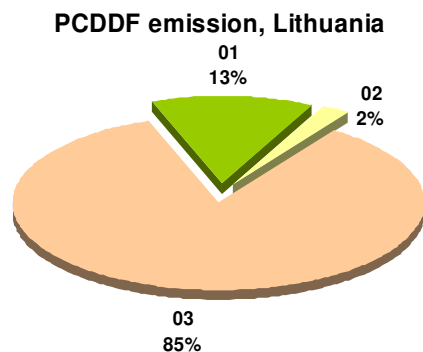


Figure 7.16. Percentage of annual total PCDD/F emission from different sectors in Lithuania for 2005

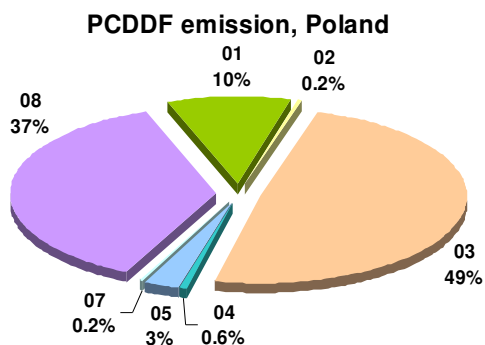


Figure 7.17. Percentage of annual total PCDD/F emission from different sectors in Poland for 2005

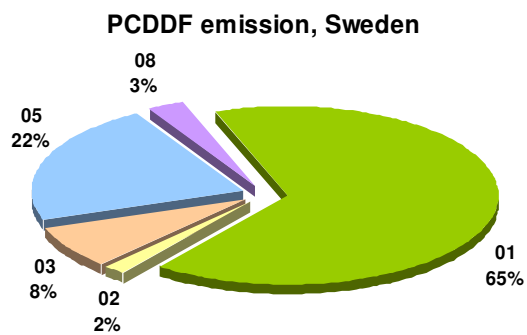


Figure 7.18. Percentage of annual total PCDD/F emission from different sectors in Sweden for 2005

Table 7.2. Annual total anthropogenic emissions of PCDD/Fs of HELCOM countries and other EMEP countries in period 1990–2005, g TEQ/year (Unofficial emissions are shaded).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Denmark	67	64	59	53	51	49	47	44	37	31	32	30	27	29	24	25
Estonia	5.7	5.4	4.3	3.6	3.8	4.5	4.9	4.8	3.8	3.4	3.4	3.5	3.7	4.1	3.7	3.3
Finland	30	33	31	32	33	34	32	32	32	32	31	31	32	32	32	26
Germany	102	93	75	71	69	78	75	81	75	72	74	74	72	72	74	74
Latvia	7	8	7	8	9	11	13	14	14	15	14	11	15	16	18	19
Lithuania	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	6.0	5.0	4.3	12.7	11.9	12.4	10.8	10.9
Poland	529	535	517	592	520	515	484	440	381	381	333	447	433	482	387	416
Russia	991	947	901	878	825	769	637	614	606	625	631	643	655	686	716	747
Sweden	60	53	50	53	44	40	38	37	35	34	33	34	34	33	36	39
HELCOM	1796	1744	1650	1697	1559	1506	1337	1271	1190	1199	1156	1286	1285	1367	1302	1360
Albania	43	43	43	43	43	43	43	43	43	43	43	43	44	44	44	44
Armenia	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47
Austria	160	135	76	67	56	58	60	60	56	54	52	55	42	42	41	43
Azerbaijan	98	98	98	98	98	98	98	98	98	98	98	99	100	101	102	102
Belarus	16	16	16	16	16	16	16	16	16	15	18	23	25	26	37	38
Belgium	569	563	529	496	489	402	347	291	235	180	124	88	59	62	65	65
Bosnia and Herzegovina	67	67	67	67	67	67	67	67	67	67	67	65	63	61	59	57
Bulgaria	554	535	515	495	476	456	341	310	288	245	233	201	219	255	239	230
Croatia	179	165	152	138	124	111	97	95	111	98	109	76	75	97	93	93
Cyprus	5.7	5.7	5.9	6.0	6.2	6.2	6.3	6.3	6.3	6.3	6.5	6.4	6.5	5.5	5.0	5.1
Czech Republic	1252	1220	1220	1140	1135	1135	922	830	767	643	744	620	177	114	187	179
France	1768	1817	1837	1895	1894	1695	1480	1044	939	614	524	390	363	240	303	220
Georgia	67	67	67	67	67	67	67	67	67	67	67	67	67	67	67	67
Greece	279	279	279	279	279	279	279	279	279	279	279	255	231	207	183	159
Hungary	172	148	104	103	100	95	90	84	74	77	74	76	75	74	74	92
Iceland	9	9	9	7.7	7.0	6.0	5.3	5.1	4.2	3.4	3.1	2.8	2.5	2.1	1.5	1.5
Ireland	27	27	27	27	27	27	27	27	27	27	27	27	27	26	27	26
Italy	529	551	532	491	478	503	454	466	446	416	396	308	293	288	298	298
Kazakhstan	40	40	40	40	40	40	40	40	40	40	40	40	41	41	41	42
Luxembourg	45	40	34	29	23	24	16	16	8	6.7	5.4	4.1	2.9	1.6	1.6	1.6
Monaco	2.4	2.4	2.7	2.9	3.2	3.2	3.4	3.8	3.6	3.6	3.7	4.0	3.5	2.9	2.6	2.6
Netherlands	743	979	752	525	297	66	56	116	44	33	31	30	29	26	28	28
Norway	130	98	96	95	94	71	50	41	35	39	34	33	32	29	32	24
Portugal	844	844	844	844	844	844	844	844	844	844	844	790	736	682	628	574
Republic of Moldova	14	11	7	5.5	5.1	3.0	3.4	2.9	6.4	2.4	2.4	2.2	2.5	3.9	5.2	5.5
Romania	113	113	113	113	113	113	113	113	113	87	101	104	103	102	100	99
Serbia and Montenegro	172	172	172	172	172	172	172	172	172	172	172	170	169	167	166	164
Slovakia	136	132	128	124	120	116	106	96	109	98	90	87	91	70	65	86
Slovenia	16	16	15	13	13	12	12	11	11	10	10	9	9	10	9	9
Spain	176	181	190	186	180	155	154	125	128	135	140	133	136	138	145	146
Switzerland	175	159	149	137	122	105	96	88	81	63	54	42	29	17	17	17
The FYR of Macedonia	166	166	166	166	166	166	166	166	166	166	166	166	166	163	163	163
Turkey	1012	1012	1012	1012	1012	1012	1012	1012	1012	1012	1012	1018	1024	1029	1035	1041
Ukraine	1022	1022	1022	1022	1022	1022	1022	1022	1022	1022	1022	1024	1026	1027	1029	1030
United Kingdom	1112	1091	1065	859	674	713	452	374	279	256	229	219	203	202	230	205
EMEP, kg TEQ/y	14	14	13	13	12	11	10	9	9	8.2	8.0	7.6	7.0	6.8	6.9	6.8

Expert estimates:

§ Denier van der Gon, H.A.C., M. van het Bolscher A.J.H. Visschedijk P.Y.J. Zandveld [2005]

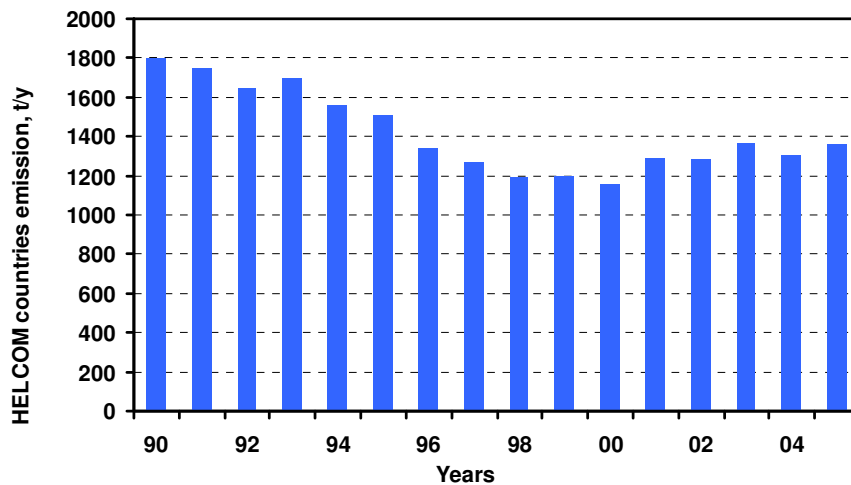


Figure 7.17. Time-series of total annual PCDD/F emissions of HELCOM countries in 1990-2005, g I-TEQ/y.

7.2 Annual deposition of PCDD/F

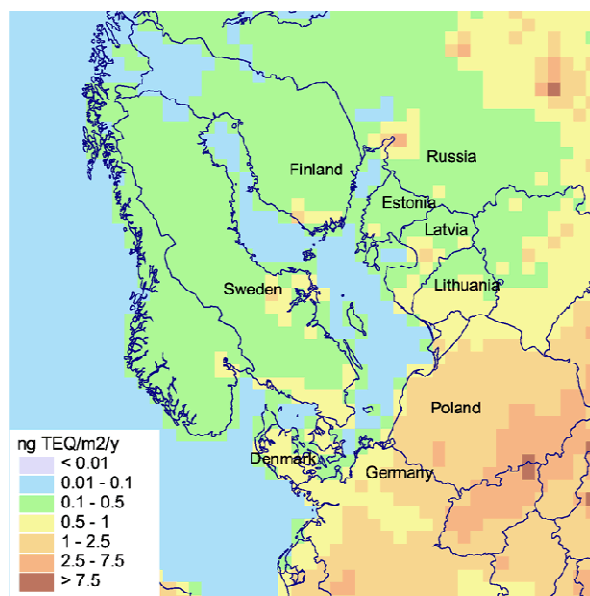


Figure 7.20. Annual deposition fluxes of PCDD/Fs over the Baltic Sea region for 2005, TEQ/m²/y.

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7.3 Monthly depositions of PCDD/F

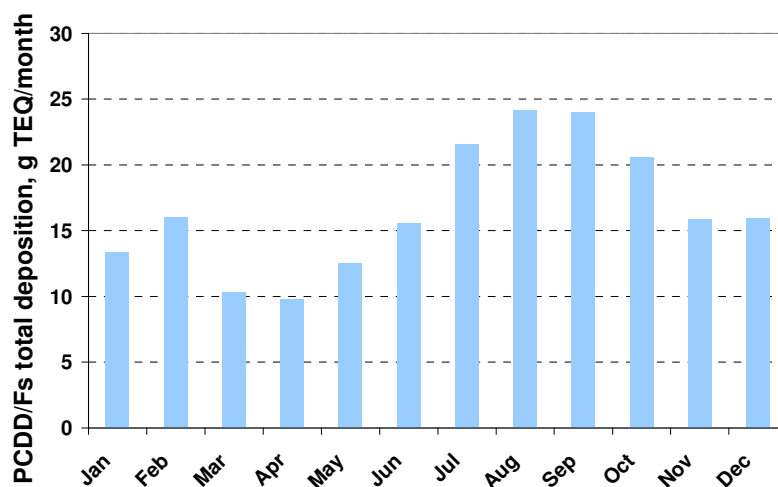


Figure 7.21. Monthly depositions of PCDD/Fs over the Baltic Sea for 2005, g TEQ/month.

Table 7.3. Monthly depositions of PCDD/Fs over the Baltic Sea for 2005, g TEQ/month.

Month	PCDD/Fs
<i>Jan</i>	13
<i>Feb</i>	16
<i>Mar</i>	10
<i>Apr</i>	10
<i>May</i>	13
<i>Jun</i>	16
<i>Jul</i>	22
<i>Aug</i>	24
<i>Sep</i>	24
<i>Oct</i>	21
<i>Nov</i>	16
<i>Dec</i>	16

7.4 Source allocation of PCDD/F deposition

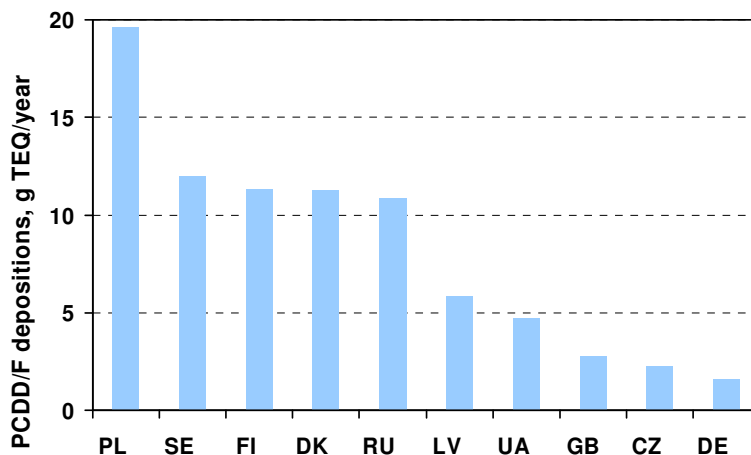


Figure 7.22. Top ten countries with the highest contribution to annual deposition of PCDD/Fs over Baltic Sea for 2005, g TEQ/y.

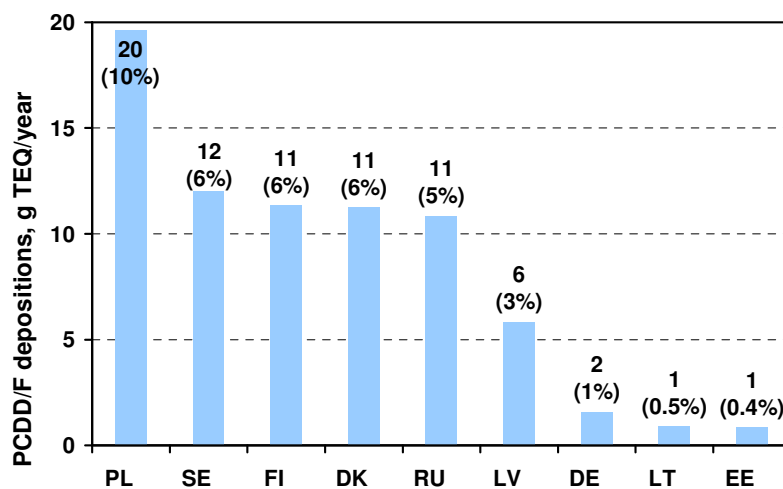


Figure 7.23. Contributions (in %) of HELCOM countries to the total PCDD/F depositions to the Baltic Sea for 2005. HELCOM countries emissions of PCDD/Fs contributed 37% to the total annual PCDD/F depositions over the Baltic Sea in 2005. Contribution of other EMEP countries accounted for 11%. Significant contribution was made by other emission sources, in particular, remote emissions sources and re-emission of PCDD/Fs (52%).

Table 7.4. Two most significant contributors to the annual total depositions of PCDD/Fs to the six Baltic Sea sub-basins for 2005.

Sub-basin	Country (1)	%	Country (2)	%	*, %
GUB	Finland	25	Sweden	14	45
GUF	Russia	35	Finland	4	43
GUR	Latvia	23	Poland	6	52
BAP	Poland	18	Sweden	6	54
BES	Denmark	21	Poland	4	62
KAT	Denmark	23	Sweden	6	55
BAS	Poland	10	Sweden	6	52

* - contribution of re-emission and remote sources.

7.5 Comparison of model results with measurements

The performance of MSCE-POP model for computation of PCDD/F pollution levels within the European region was evaluated during the model review carried out in the framework of EMEP Task Force on Monitoring and Measurements. In particular, MSCE-POP model results on long-range transport of one of the toxic PCDD/F congeners 2,3,4,7,8-PeCDF for the EMEP region and the period 1990-2003 were compared with measurements of EMEP monitoring network and observations of other studies within the European region. One of the main conclusions of the TFMM Workshop on the Review of the EMEP Models on Heavy Metals and Persistent Organic Pollutants in Moscow in 2005 was that “the MSCE-POP model represents the state-of-the-science and fits to the purpose of evaluating the contributions of long-range transport to the environment impacts caused by POPs”. It was recognized that the MSCE-POP model results demonstrated its ability to provide spatially and temporally resolved air concentrations and depositions of POPs across Europe. The model provided reasonable agreement with long-term temporal trends of air pollution at most EMEP monitoring sites.

Modelling results for PCDD/Fs obtained for 2004 were compared with available measurement data of monitoring campaign carried out in Denmark. The results of the comparison are presented in the previous Joint report of EMEP Centres for HELCOM (*Barnicki et al.*, 2006).

In this report no results of comparison of modeling results with measurement is presented since there was no available measurements of dioxins and furans within the European region for 2005 were found.