COMPILATION OF EU DIOXIN EXPOSURE AND HEALTH DATA: ENVIRONMENTAL LEVELS

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Introduction

Worldwide many countries have performed a multitude of dioxin analyses in order to determine the concentrations of polychlorinated dibenzo-*p*-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) in environmental media and other matrices. The European Commission has commissioned a project to collect and evaluate PCDD/PCDF results from the fifteen Member States in order to have a better overview of existing data and to provide a basis for a common policy for these substances [1]. The project will be concluded in fall 1999. If possible, from the data available so far, trend analysis for selected media or countries may give an indication whether measures taken to reduce the releases of PCDD/PCDF have been successful.When analyzing PCDD/PCDF concentrations in various environmental matrices, it should be taken into account that some matrices such as ambient air and vegetation are sensitive to short-term or recent inputs and in addition, are sensitive towards temporal variation. Other matrices such as sediments or soils are highly accumulating having a "long memory" and thus, cores can be used for evaluation of historic trends. Normally, it is almost impossible to determine the time when the dioxin contamination occurred.

Materials and Methods

The data in this study have been collected through literature search and many contacts with research and government organizations. All concentrations reported are normalized to I-TEQ and N-TEQ for the Nordic countries.

Results

A summary of the matrices where PCDD/PCDF concentrations were determined is shown in Table 1. Most countries have investigated PCDD/PCDF concentrations in soil and to a lesser extent in air and sediments. Intensive monitoring programs were performed in Germany and the United Kingdom; fewer data exist from Austria, Sweden, Spain, Denmark, and Finland. For cow's milk, Table 1 only lists only the countries, which have performed PCDD/PCDF analyses for environmental impact assessment. From some countries, PCDD/PCDF concentrations from sewage sludge, commodity goods, and wastes were available as well.
Most data are available for PCDD/PCDF concentrations in soils due to intensive surveys. In almost all countries, a broad range of PCDD/PCDF concentrations was detected with the lowest concentrations around 1 ng I-TEQ/kg d.m. and upper-bound numbers to several hundred or more than 1,000 ng I-TEQ/kg d.m. in hotspots. So far, only low concentrations were reported from Belgium, Spain and Ireland (see Table 2). However, the database for these countries is very small.

Table 1: Overview of environmental matrices analyzed by Member States of the EU.
* indicates biomonitor; ** biomonitor close to point source,
(x) few data or of poor quality

	A	B	DK	D	E	F	FIN	GR	I	IRE	L	NL	P	S	UK
Soil	X	X	(x)	X	X		X	X	X	X	X	X		X	X
Sediment				X	X		X		X		X	X			X
Air	X	X		X					X		X	X		X	X
Vegetation	X			X		X**	X								X
Wildlife				X			X							X	X
Cow milk *	X**					X**				X					
Water														X	

Table 2: Summary of PCDD/PCDF concentrations in soil from EU Member States.
Concentrations in ng TEQ/kg d.m.

	Any type	Forest	Pasture	Arable	Rural	Contamin.
Austria		0.01-64	1.6-14			332
Belgium	2.7-8.9				2.1-2.7	
Finland						85000
Germany	0.1-42	10-30	0.004-30	0.03-25	1	30000
Greece	2-45					1144
Ireland	0.15-8.6	4.8	0.8-13			
Italy	0.057-0.12		0.1-43	1.9-3.1		
Luxembourg	1.8-20	6.0			1.4	
The Netherlands	2-55				2.2-17	98000
Spain	0.63-8.4				0.1-8.4	
Sweden					0.11	11446
United Kingdom	0.78-87				0.78-20	1585

PCDD/PCDF concentrations in sediments from EU Member States are summarised in Table 3. Normally, the ranges are from a few ng TEQ/kg d.m. to ca. 50 ng TEQ/kg d.m. However, hotspots were identified in many countries where concentrations exceed 1,000 ng TEQ/kg d.m.

Table 3: Summary of PCDD/PCDF concentrations in sediments from EU Member States.
Concentrations in ng TEQ/kg d.m.

	Finland	Germany	Italy	Lux.	Netherl.	Spain	Sweden	UK
Background	0.7-100	1.2-19	0.07-10		1-10		0.8-207	
Urban		12-73	0.5-23	2.4-16		0.2-57		2-123
Contaminated	80000	>1500	570		4000		1692	7410

Results for air samples were available for only eight countries (Table 4). There are three basic approaches to determine the PCDD/PCDF concentrations in air: high volume samplers which will

collect particle-bound and gas-phase PCDD/PCDF, Bergerhoff or similar samplers which will collect dry and wet deposition and biomonitors such as kale, spruce needles or grass which preferentially absorb the gas-phase dioxins and furans.
Table 4 shows that, once again, the concentrations in ambient air range from 1 to several hundred fg I-TEQ/m³ and in deposition, a similar range was found for the concentrations in pg TEQ/m²·d.

Table 4: Summary of air concentrations from EU Member States. Concentrations of ambient air samples in fg TEQ/m³ and deposition in pg TEQ/m²·d

	Ambient Air			Deposition		
	Unspecified	Urban	Rural	Urban	Rural	Contaminated
Austria	1.3-587					
Belgium		86-129	70-125	0.9-12	0.7-3.1	
Germany	1-705			0.5-464		
Italy	85	47-277				
Luxembourg		54-77	30-64			
The Netherlands	4-99		9-63			6-140
Sweden		0.2-54				
United Kingdom		17-103	6-12	0.4-312	0-517	14800

Vegetation has been utilized by many countries to monitor ambient air concentrations. The use of these biomonitors was found useful for both routine programs on a long-term basis or to identify potential hotspots around potential point sources. The use of kale was successfully implemented around a steel producing plant in Luxembourg where mean concentrations up to 10 ng I-TEQ/kg d.m. were detected; in Germany 12.6. ng I-TEQ/kg d.m. were determined close to combustion sources. In Austria, spruce needles are utilized as biomonitors: the background concentrations were in a very narrow range between 0.3 and 1.9 ng I-TEQ/kg d.m. Normally, baseline concentrations were around 0.5 ng I-TEQ/kg d.m. in rural areas and around 1-1.7 ng I-TEQ/kg d.m. in urban areas. Studies from Bavaria and Hesse in Germany reported that mean PCDD/PCDF concentrations in pine needle ranged from 0.53 to 1.64 pg I-TEQ/g d.m. However, in the neighborhood of the Brixlegg copper reclamation plant between 51 and 86 ng I-TEQ/kg were determined. In Welsh Rye grass, which is typically exposed for four weeks during the summer, concentrations normally are between 0.5 and 1 ng I-TEQ/kg d.m.
Fish and shellfish were frequently used as biomonitors for the aquatic environment. As can be seen from Table 5, fish are highly bioaccumulative for PCDD/PCDF so that several hundred pg TEQ/g fat were detected in these animals. These concentrations are much higher than those found in terrestrial animals, such as cattle, pig, or chicken.
Top-predators like sea eagles or guillemots also showed high concentrations of PCDD/PCDF: as an example in Finland, 830 to 66,000 pg TEQ/g fat were found in white-tailed sea eagles. The Swedish Dioxin Database reported a wide range of dioxin concentrations in the blubber of ringed seal: 6.3 to 217 pg TEQ/g fresh weight.

Table 5: Summary of fish concentrations from EU Member States. Concentrations in pg TEQ/g fat

	Finland	Germany	Sweden	United Kingdom
Concentration	75-200	40-51	9.1-420	16-700

Discussion

During this project a lot of quantitative data were collected from Member States of the European Union. All countries delivered the information in TEQ; some older data were on homologue basis only but were not used in this project. The number of data for a given country and a given environmental matrix differed largely. For some countries, such as Germany, the United Kingdom, Finland, and the Netherlands, there exists a large database on PCDD/PCDF concentrations in the environment. However, the coverage per matrix varies from country to country: as an example, there are many data on wildlife in Finland whereas there are only a few data for Germany. On the other hand, Germany and the United Kingdom concentrated many activities on ambient air monitoring. So far, there are no PCDD/PCDF data available for Portugal. However, there are several studies in progress so that in the near future, data will be available from this country as well. Other countries will use advanced methodology to update and enlarge their database; *e.g.* Denmark will perform a dioxin program in the year 2001 and will also include Greenland and the Faroe islands.

There are many data available, however, due to the public attention the general public pays to dioxins and furans, many studies aim to identify potential "hot spots" and thus, very often more samples are taken from contaminated matrices rather than from "normal" or baseline matrices. As a result, the overall presentation of the data is biased towards contaminated samples.

Although there are thousands of data available, it is impossible to determine median or average concentrations for any matrix or any country as data from all sources were aggregated and thus, could not be merged. The exception is Sweden, where we received the TEQ-values for individual samples and thus, mathematical evaluations could be performed. The major drawback of the Swedish data (S-EPA 1998), however, is the time coverage: the most recent data are for the year 1993 and thus, are not representative of today's environment.

A further conclusion of the data evaluation is that in most cases it is impossible to distinguish between remote and urban sites, as *e.g.,* in a remote area, a point source may contaminate sediments or soils due to the characteristics of the activity present. For air, there were overlaps identified in almost all monitoring programs. A seasonal trend with higher PCDD/PCDF concentrations in winter and lower concentrations in summer was confirmed many times.

Despite of all of these drawbacks, the project proved to be helpful to obtain an overview of the present status of PCDD/PCDF contamination in the Member States of the European Union. The results from this study will help countries to rank their own activities with respect to activities and experiences obtained in neighboring countries and may direct further activities. For the DG XI, the results from this project together with the source characterization/inventory program led by the Landesumweltamt Nordrhein-Westfalen will help to set further priorities for dioxin reduction measures and identify needs for further information gathering or research programs.

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References

1 EU (1997): Compilation of EU Dioxin Exposure and Health Data. European Commission, DG XI, Brussels, Belgium. Report in preparation