

## PCDD/PCDF Release Inventories

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### Introduction

The Stockholm Convention on Persistent Organic Pollutants (POPs) entered into force on 17 May 2004 with 50 Parties. In May 2004, 59 countries had ratified or acceded to the Convention. The objective of the Convention is “to protect human health and the environment from persistent organic pollutants”<sup>i</sup>. For intentionally produced POPs, *e.g.*, pesticides and industrial chemicals such as hexachlorobenzene and polychlorinated biphenyls, this will be achieved by stop of production and use. For unintentionally generated POPs, such as polychlorinated dibenzo-*p*-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF), measures have to be taken to “reduce the total releases derived from anthropogenic sources”; the final goal is ultimate elimination, where feasible<sup>ii</sup>. Under the Convention, Parties have to establish and maintain release inventories to prove the continuous release reduction. Since many countries do not have the technical and financial capacity to measure all releases from all potential PCDD/PCDF sources, UNEP Chemicals has developed the “Standardized Toolkit for the Identification of Quantification of Dioxin and Furan Releases” (“Toolkit” for short)<sup>iii</sup>, a methodology to estimate annual releases from a number of sources. With this methodology, annual releases can be estimated by multiplying process-specific default emission factors provided in the Toolkit with national activity data. At the seventh session of the Intergovernmental Negotiating Committee, the Toolkit was recommended to be used by countries when reporting national release data to the Conference of the Parties. The Toolkit is especially used by developing countries and countries with economies in transition where no measured data are available. Results from Uruguay, Thailand, Jordan, Philippines, and Brunei Darussalam have been published<sup>iv</sup>.

### Materials and Methods

In 2002/2003 UNEP Chemicals has assisted Latin American and Asian countries in the development of their PCDD/PCDF release inventories through subregional workshops and national training activities. All countries have applied the Toolkit in the estimation of their national releases. No sampling and analyses were undertaken in the course of these projects.

## Results

Table 1 to Table 5 show the releases of PCDD/PCDF in g TEQ per year for each main source category and release vector for five countries. "0" in the Tables stands for that either this release vector is not relevant or there is no emission factor provided to allow estimation of the respective release.

**Lebanon** is a small country in the Middle East region with a land area of 10,542 km<sup>2</sup>: In 1999, the population was 4.35 million. The Republic of Lebanon, signed the Stockholm Convention in May 2001 and ratified it on 8 August 2003. The releases of PCDD/PCDF for the reference year around 1999/2000 is shown in Table 1 and were estimated at 77.5 g TEQ per year. Among the source categories the uncontrolled combustion processes accounted for 70 % and the waste incineration for 15 %. Of the total releases, emissions to air were 38.5 g TEQ/a whereas only 1 g TEQ/a was released to water. 37 g TEQ/a were released in solid residues, mainly the ashes from uncontrolled combustion processes and from the ferrous and non-ferrous production sector<sup>v</sup>.

**Vietnam** is a coastal nation in the South East Asian region with an area of around 331,000 km<sup>2</sup> and about 78.4 million inhabitants. On 23 May 2001, Vietnam signed the Stockholm Convention and 22 July 2002 it became the 13<sup>th</sup> Party to the Convention. The total PCDD/PCDF releases were estimated at 68.8 g TEQ/a whereby 15.97 g TEQ/a were releases to air, 1.46 g TEQ/a to water, 1.05 g TEQ/a to land, 2.19 g TEQ/a in products, and 48.16 g TEQ/a in residues (Table 2). However, these numbers are considered preliminary and need further revision<sup>v</sup>.

**Argentina** lies in South America and has a surface of 3.7 million km<sup>2</sup>; the population is 37.4 million. The results in Table 3 show that the dominating source category is uncontrolled combustion with an estimated 684 g TEQ to air and 241 g TEQ in residues. Of these 356 g TEQ to air and 241 g TEQ in residues result from forest and grass fires and agricultural burning practices. Although these results are preliminary, it shows the importance of this subcategory for the overall inventory<sup>vi</sup>.

**Cuba** is an archipelago in the Caribbean with about 4,195 islands and a population of 11.2 million in the year 2000. The results in Table 4 show that in the year 2000, 319 g TEQ were released from identified sources; of these 61 % were emitted to air and 35 % with residues. The other release vectors were less important (2 % to each, land and products, and less than 1 % to water, respectively). The major source categories were uncontrolled combustion processes (34 %), waste incineration (29 %), and generation of energy (28 %). Within the subcategories, medical waste incineration and energy generation from biomass were especially important. The releases in residues were mainly due to the open burning of domestic waste<sup>vii</sup>.

**Paraguay**: is a land-locked country in South America with a surface of 406,752 km<sup>2</sup> and 5.2 million population (2002 census). In the base year 2002, the total PCDD/PCDF releases were 156 g TEQ per year (Table 5), corresponding to 30 µg TEQ per person and year (Table 6). The dominating release vectors were with residues (48.9 % or 76.3 g TEQ/a) and to air (45.3 % or 70.7 g TEQ/a). Among the releases to residues, the ashes from the open burning of waste in landfills and at home accounted for 99 % of the total. Open burning of waste also was the largest source of PCDD/PCDF emitted to air (86 %) whereby also agricultural and forest fires have to be mentioned. Hospital waste incinerators were responsible for 4.9 % of the emissions to air. It should be noted that the use of biomass, *e.g.*, wood and vegetal coal, for heating and cooking, and of LPG caused 4.5 % of the emissions to air<sup>viii</sup>.

## NONTHERMAL SOURCES AND SOURCE INVENTORIES

An overview of PCDD/PCDF releases to air per person and country is shown in Table 6.

Table 1: PCDD/PCDF release inventory for Lebanon, reference year 1999/2000

Cat.	Source Categories	Releases (g TEQ/a)				
		Air	Water	Land	Products	Residue
1	Waste Incineration	11.6	0	0	0	0.1
2	Ferrous and non-ferrous metal production	1.9	0	0	0	4.0
3	Power generation and heating	0.35	0	0	0	0
4	Production of mineral products	0.52	0	0	0	0
5	Transportation	2.46	0	0	0	0
6	Uncontrolled combustion processes	21.0	0	0.055	0	33.0
7	Production of chemicals + consumer goods	0.70	0	0	0.024	0
8	Miscellaneous	0	0	0	0	0
9	Disposal/Landfilling	0.035	0.964	0	0.781	0
<b>1-9</b>	<b>Total</b>	<b>38.5</b>	<b>1.0</b>	<b>0.1</b>	<b>0.8</b>	<b>37.1</b>
	<b>Grand Total</b>	<b>77.5</b>				

Table 2: PCDD/PCDF release inventory for Vietnam, reference year 2000

Cat.	Source Categories	Annual Releases (g TEQ/a)				
		Air	Water	Land	Product	Residue
1	Waste Incineration	3.36	0	0	0	0.82
2	Ferrous and non-ferrous metal production	1.10	0	0	0	2.64
3	Power generation and heating	5.12	0	0	0	42.51
4	Production of mineral products	2.18	0	0	0	0.16
5	Transportation	0.98	0	0	0	0
6	Uncontrolled combustion processes	2.96	0	1.05	0	0.52
7	Production of chemicals + consumer goods	0	0	0	1.96	0.91
8	Miscellaneous	0.26	0	0	0.07	0
9	Disposal/Landfilling	0	1.45	0	0.16	0.61
<b>1-9</b>	<b>Total</b>	<b>15.97</b>	<b>1.46</b>	<b>1.05</b>	<b>2.19</b>	<b>48.16</b>
	<b>Grand Total</b>	<b>68.8</b>				

## NONTHERMAL SOURCES AND SOURCE INVENTORIES

Table 3: PCDD/PCDF release inventory for Argentina, reference year 2001

Cat.	Source Categories	Annual Releases (g TEQ/a)				
		Air	Water	Land	Product	Residue
1	Waste Incineration	83.1	0	0	0	43.1
2	Ferrous and non-ferrous metal production	26.1	0	0	0	69.9
3	Power generation and heating	31.1	0	0	0	42.2
4	Production of mineral products	6.49	0	0	0	0.05
5	Transportation	3.08	0	0	0	0
6	Uncontrolled combustion processes	715	0	241	0	718
7	Production of chemicals + consumer goods	1.10	0	0	22.8	65.1
8	Miscellaneous	8.10	0	0	0	0
9	Disposal/Landfilling	0	2.5	0	6.6	25.3
<b>1-9</b>	<b>Total</b>	<b>874</b>	<b>2.5</b>	<b>241</b>	<b>29.4</b>	<b>964</b>
	<b>Grand Total</b>	<b>2,111</b>				

Table 4: PCDD/PCDF release inventory for Cuba, reference year 2000

Cat.	Source Categories	Annual Releases (g TEQ/a)				
		Air	Water	Land	Product	Residue
1	Waste Incineration	56.4	-	-	-	0.74
2	Ferrous and non-ferrous metal production	13.7	0.003	-	-	8.23
3	Power generation and heating	55.4	-	-	-	0.72
4	Production of mineral products	3.81	-	-	-	0.86
5	Transportation	0.42				
6	Uncontrolled combustion processes	65.5	-	4.96	-	100
7	Production of chemicals + consumer goods				0.52	
8	Miscellaneous	0.11	-	-	0.01	
9	Disposal/Landfilling		1.30		5.12	0.69
<b>1-9</b>	<b>Total</b>	<b>195</b>	<b>1.3</b>	<b>5.0</b>	<b>5.6</b>	<b>112</b>
	<b>Grand Total</b>	<b>319</b>				

## NONTHERMAL SOURCES AND SOURCE INVENTORIES

Table 5: PCDD/PCDF release inventory for Paraguay, reference year 2002

Cat.	Source Categories	Annual Releases (g TEQ/a)				
		Air	Water	Land	Product	Residue
1	Waste Incineration	3.50	0	0	0	0.023
2	Ferrous and non-ferrous metal production	1.52	0.03	0	0	0
3	Power generation and heating	3.10	0	0	0	0.6
4	Production of mineral products	1.07	0	0	0	0.06
5	Transportation	0.37	0	0	0	0
6	Uncontrolled combustion processes	61.1	0	8.50	0	76.2
7	Production of chemicals + consumer goods	0	0	0	0.0002	
8	Miscellaneous	0.03	0	0	0.221	0
9	Disposal/Landfilling	0	0.17	0	0	0
<b>1-9</b>	<b>Total</b>	<b>70.7</b>	<b>0.2</b>	<b>8.5</b>	<b>0.22</b>	<b>76.3</b>
	<b>Grand Total</b>	<b>156</b>				

Table 6: PCDD/PCDF releases per inhabitant and year

Country	Inhab ·mio	Air Releases per year		Country	Inhab ·mio	Air Releases per year	
		g TEQ	µg TEQ/inhab			g TEQ	µg TEQ/inhab
Argentina	37.4	838	22	<i>Lithuania</i>	3.6	17	5
Brunei	0.34	0.75	2	Paraguay	5.2	70.7	14
Cuba	11.2	195	17	Philippines	84.5	328	4
<i>Estonia</i>	<i>1.42</i>	<i>14</i>	<i>10</i>	<i>Poland</i>	<i>38.6</i>	<i>490</i>	<i>13</i>
Jordan	5.3	53.6	10	Thailand	62.4	985	16
<i>Latvia</i>	<i>3.4</i>	<i>22</i>	<i>6</i>	Uruguay	3.3	17.1	5
Lebanon	4.37	38.5	8.8	Vietnam	78.4	16	0.2

### References:

- <sup>i</sup> Stockholm Convention (2001): Stockholm Convention on Persistent Organic Pollutants. Full text for download in English [http://www.pops.int/documents/convtext/convtext\\_en.pdf](http://www.pops.int/documents/convtext/convtext_en.pdf); other language versions at <http://www.pops.int>
- <sup>ii</sup> Article 5 of the Convention
- <sup>iii</sup> Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases, First edition, May 2003. UNEP Chemicals, <http://www.pops.int/documents/guidance/>
- <sup>iv</sup> H. Fiedler (2003): First Results of Release Inventories of PCDD/PCDF under the Stockholm Convention. *Organohalogen Compd.* **63**, 1-4
- <sup>v</sup> UNEP (2003b): Asia Dioxin Toolkit Project - National PCDD/PCDF Release Inventories from Brunei Darussalam, Jordan, Lebanon, Philippines, and Vietnam. UNEP Chemicals, Geneva

- <sup>vi</sup> Argentina (2004): Inventario nacional de liberaciones de dioxinas y furanos : Argentina – 2001. SAyDS - Secretaria del Ambiente y Desarrollo Sustentable, Buenos Aires, Argentina
- <sup>vii</sup> Cuba (2004): Inventario Nacional de fuentes y liberaciones de dioxinas y furanos - Cuba 2000C. CITMA-CIGEA, La Havana, Cuba
- <sup>viii</sup> Paraguay (2003): Inventario nacional de liberaciones de dioxinas y furanos: Paraguay 2002. Secretaria del Medio Ambiente, Asunción, Paraguay, December 2003