

## PCDD/PCDF INVENTORIES 1990 vs. 2012

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### Introduction

Inventories of persistent organic pollutants (POPs) have attracted scientific and political interest because they form the basis for release reduction measures that are often required by countries as part of their reporting obligations within multilateral environmental agreements. Despite this political context, first POPs inventories have been developed by scientists and are steadily improving as scientific knowledge and technology improve. Since more than 20 years, dioxin inventories have been presented.

This paper presents an overview on national PCDD/PCDF inventories from the early 1990s until today.

### Materials and methods

Early PCDD/PCDF inventories have been compiled from the published literature and national reports. With the entry into force of the Stockholm Convention on Persistent Organic Pollutants official national reporting has gained importance and information has been drawn from, *e.g.*, submissions of parties to the Stockholm Convention according to national reporting under article 15 or from national implementation plans prepared according to article 7. Statistical data on population, economics and major pollutant emissions have been extracted from the World Bank database<sup>1</sup>.

For 2012 assessment, the national inventories have been entered into a databank of national PCDD/PCDF inventories following the compiled according to the UNEP Toolkit methodology for estimating PCDD/PCDF releases into the environment with five vectors and ten source groups<sup>2</sup>.

### Results and discussion

At Dioxin'90, Fiedler and coworkers published the paper entitled "Dioxin Emissions to Air: Mass Balance for Germany Today and in the Year 2000"<sup>3</sup>. The results were mainly based on measured emission data and had a total annual emission of 928.5 g I-TEQ to air from sources in Germany (former Federal Republic of Germany). Although releases in solid residues such as slags, fly ashes, sludges have been quantified, a systematic approach for estimating these releases had not been undertaken.

In 1999, UNEP published a report presenting the results of 15 emission inventories; the reference year was around 1995. Figure 1 shows the distribution of sources within and between countries.

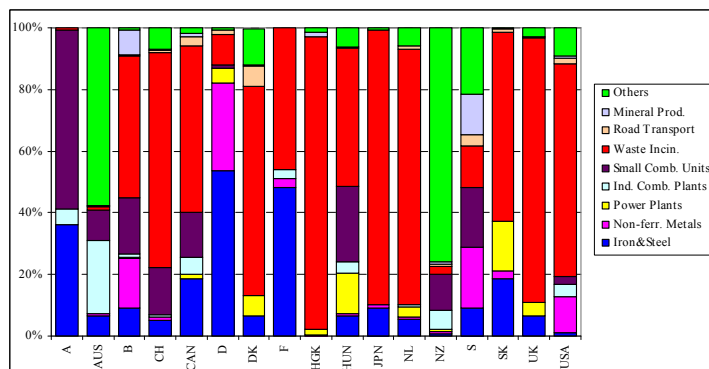


Figure 1: Distribution of PCDD/PCDF emissions according to emission source group and *per* country (1999 report)

In the early 2000s and presented at Dioxin2004 in Berlin<sup>4</sup>, 23 national release inventories were available that have been made with the UNEP Toolkit methodology<sup>5</sup>. Among the most important sources, open fires in agriculture/forests as well as open burning of wastes have been identified as the major sources of PCDD/PCDF. At Dioxin2007, Fiedler<sup>6</sup> presented the actual status of global POPs inventories, which were divided into two types of PCDD/PCDF inventories:

1. Estimated releases of PCDD/PCDF to air and as totals by countries that did not apply the UNEP Toolkit methodology:  
Air emissions were 3,804 g TEQ yr<sup>-1</sup> and total releases were 4,148 g TEQ yr<sup>-1</sup>;
2. Estimated releases by countries that applied the UNEP Toolkit methodology:  
Air emissions were 10,911 g TEQ yr<sup>-1</sup> and total releases 23,877 g TEQ yr<sup>-1</sup>.

In this presentation, for the first time, so-called “population equivalents” in µg TEQ *per* year were included. Such normalization was found to be helpful to put results into perspective and which can also serve as an orientation for a country if the own estimate fits into the scale of estimates from other countries. Across all countries, it was found that the following average releases *per* capita and *per* year did apply: 12 µg TEQ yr<sup>-1</sup> person<sup>-1</sup> to air and 21 µg TEQ yr<sup>-1</sup> person<sup>-1</sup> for total releases.

In 2011, 68 release inventories have been available. The total releases accounted for 58,700 g TEQ *per* year (Figure 2). The reference years ranged from 1999 to 2009. The main vector of release was air corresponding to 45% of total releases, second highest was releases in residues (34%) (Figure 3). Releases to water only played minor role (Table 1).

Table 1: Summary of PCDD/PCDF releases

Releases (g TEQ per year)				
Air	Water	Land	Product	Residue
26,400	1,200	6,000	5,300	19,800
<b>45%</b>	<b>2%</b>	<b>10%</b>	<b>9%</b>	<b>34%</b>
<b>Grand total (ca.)</b>			<b>58,700</b>	

With respect to importance of the source groups:  
 48% were from open burning of biomass or waste  
 12% from incineration of waste  
 10% from conversion of energy (power generation, heating and cooking)  
 9% from (non-)ferrous metals production

Releases are always reported in g toxic equivalents *per* year (g TEQ yr<sup>-1</sup>). Depending on the reference or reporting units, the emissions will be grouped according to:

- National total releases *per* source group (Figure 4)
- National total releases *per* capita (Figure 5)
- National total releases *per* square kilometer (Figure 6)
- National total releases *per* unit of gross national product (Figure 7)

From the above, priorities between countries based on economic status can be assessed.

## References:

- 1 Worldbank <http://databank.worldbank.org/ddp/exportData>
- 2 UNEP (2005) Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases. UNEP Chemicals, Geneva, Switzerland [http://www.chem.unep.ch/pops/pcdd\\_activities/toolkit/default.htm](http://www.chem.unep.ch/pops/pcdd_activities/toolkit/default.htm)
- 3 Fiedler H, Schramm W, Hutzinger O (1990) *Organohalogen Compd* 4: 395-400
- 4 Fiedler H (2004) *Organohalogen Compd* 66: 947-952
- 5 Fiedler H (2007) *Chemosphere* 67: S96–S108
- 6 Fiedler H (2007) *Organohalogen Compd* 69: 1-6

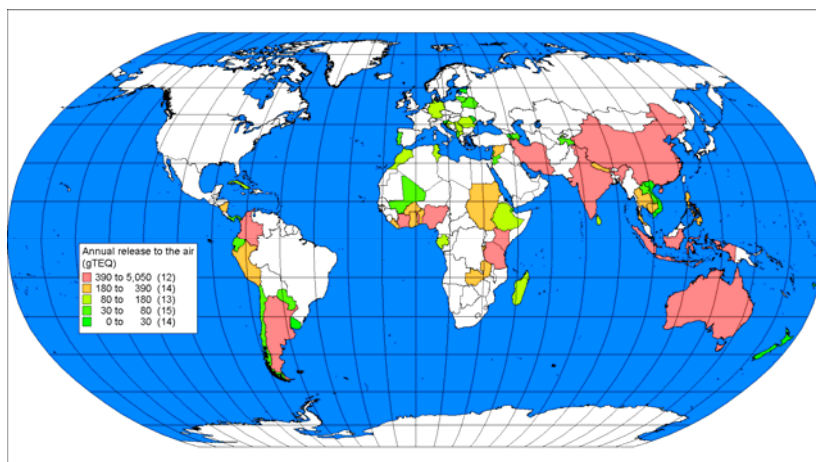


Figure 2: Total annual releases *per country* (g TEQ/year)

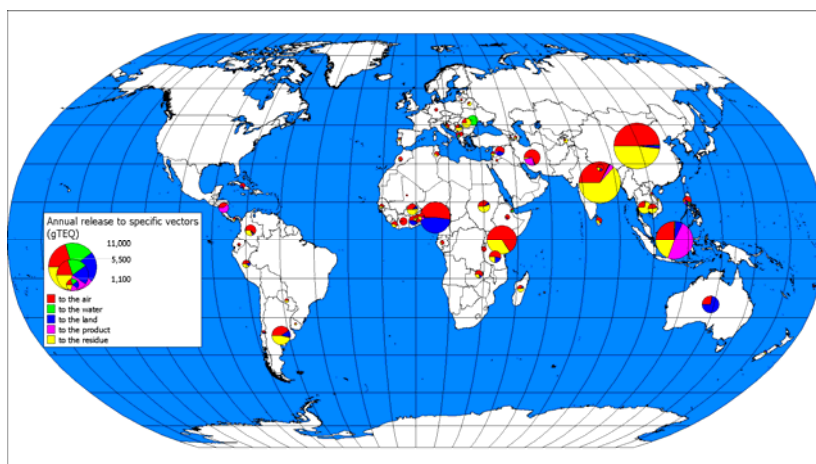


Figure 3: Total annual releases *per country and release vector* (g TEQ/year)

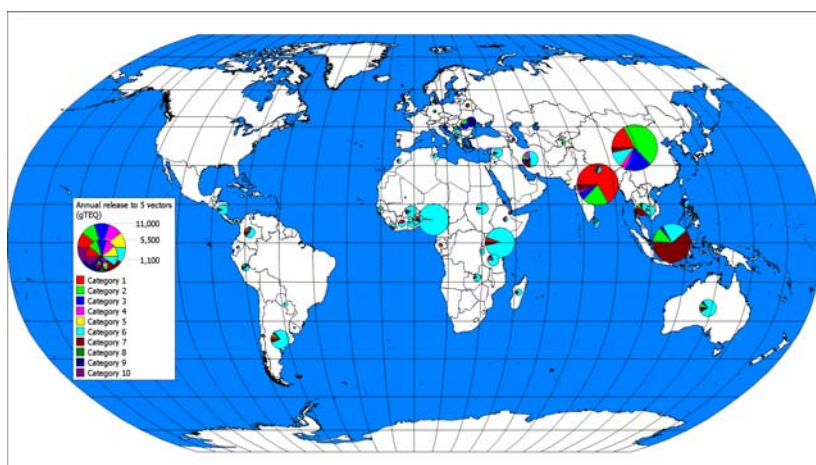


Figure 4: National total releases *per source group*(g TEQ/year)

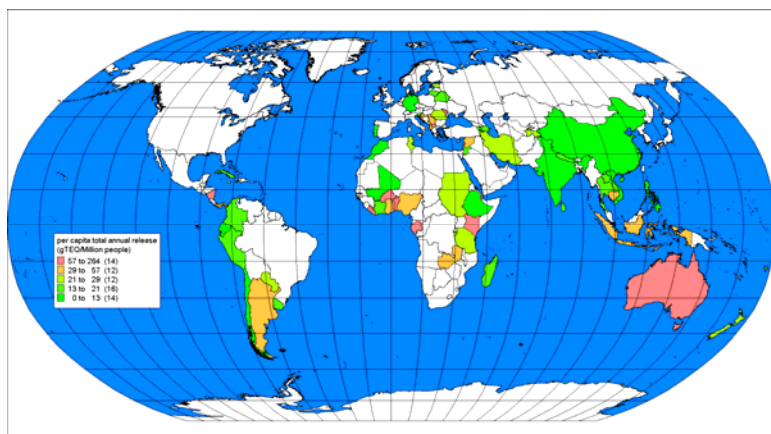


Figure 5: National total releases *per capita* (g TEQ/year and inhabitant)

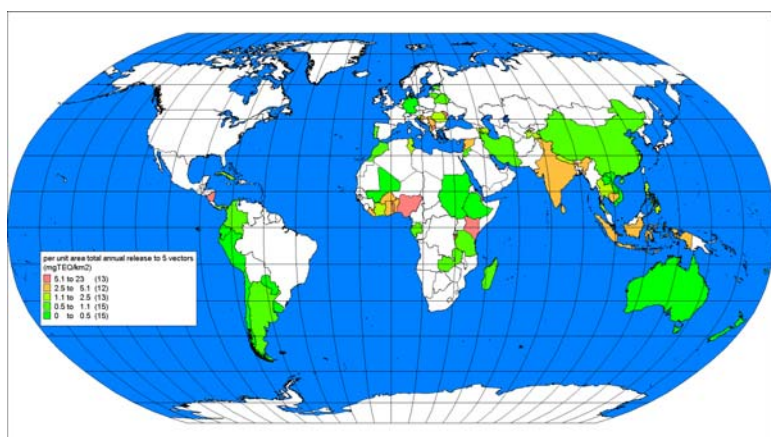


Figure 6: National total releases *per square kilometer*(g TEQ/year and km<sup>2</sup>)

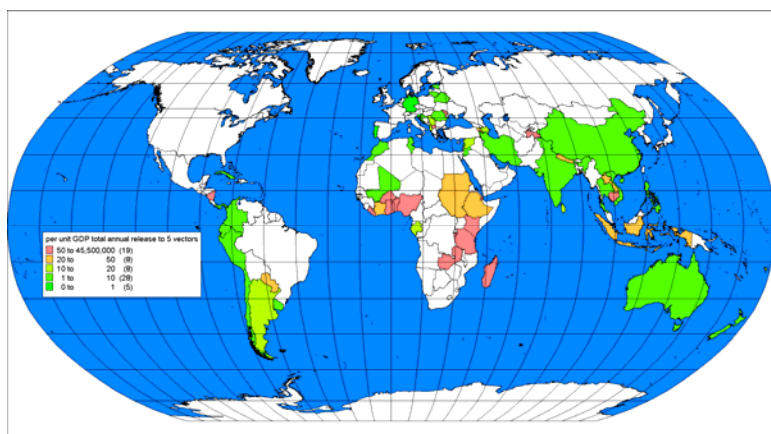


Figure 7: National total releases *per unit of gross national product*