

THE MEXICAN EXPERIENCE IN THE ELABORATION OF RELEASE INVENTORIES OF PCDD/PCDF

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Introduction

PCDD/PCDF are two of the twelve persistent organic pollutants (POPs) identified by the Stockholm Convention, a global legally binding treaty, to minimize or, where feasible, eliminate their releases to the environment ¹. In order to accomplish such initiative release sources must be identified and quantified. Analytical determination of PCDD/PCDF pose several difficulties, due to the need for expensive equipment, highly specialized personnel required, elevated costs per sample analyzed and multitude of sources present in the country ^{2,3}. Additionally, this burden is magnified by the global need to homogenize sampling and analysis methods. Therefore, a few countries have developed PCDD/PCDF inventories largely based in their own measured data from their sources. Instead, releases are estimated through application of emission factors generated either in the respective country or adopted from foreign measurements. Notwithstanding this, while information reflected in those documents is considered very valuable, comparison between inventories as well as extrapolation to different countries situations and activities cannot be done in a satisfactory way ^{4,5,6}.

In 2002, in the frame of the North American Commission Environmental Cooperation (NACEC), Mexico elaborated its first PCDD/PCDF release inventory, through the application of emission factors used by the US Environmental Protection Agency (US EPA) ⁷. Whilst the obtained results threw valuable light about the main sources and emission trends in the country, it was concluded that further work was needed, and new emission factors were required to obtain an inventory that better reflects the reality of the country's situation. In 2003, UNEP Chemicals released the Standardized Toolkit for the Identification and Quantification of PCDD/PCDF Releases, to harmonize estimation procedures and allow comparability between inventories from different countries ⁵. Mexico applied the UNEP Toolkit methodology and emission factors contained therein with the data of its first inventory when US-EPA emission factors have been applied. Both methods and results were compared in order to define which of them would better reflect the situation and the needs of the country.

Methods

The basic approach for the Mexican release inventories consisted on gathering "activity statistics", describing the scale of a defined process or activity per year. Emission factors describing releases of PCDD/PCDF are then applied to estimate the annual releases to the environment. The first Mexican inventory considered 13 different activities (Table 1), identified as relevant sources according to the USEPA inventory ⁷. The application of the UNEP Toolkit with the Toolkit's default emission factors in Mexico considered the same activity statistics but classified the selected process activities according to the subcategories provided by the Toolkit ⁸.

Results and Discussion

Both methodologies were studied and compared, taking into account the existing differences between them, in the way that activities are considered and technologies are classified. Whilst the USEPA centered its efforts on using available data on PCDD/PCDF releases measured from only the United States, or using data generated in other countries with similar conditions, the UNEP Toolkit emission factors were derived from a much broader database of measured data world-wide. In addition, the Toolkit was developed to be used also by countries that do not have the same degree of sophistication in their processes as seen in developed countries.

Several divergences were found when both methods were compared, mainly related to the emission factors magnitude, activities and technologies classification, among others. Yet, similarities were also found, linked to the

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level of uncertainty in the estimation, the need of better and more reliable data and, to some extent, a very akin activity releases importance rank (Table 1). From this analysis, it was concluded that the UNEP Toolkit method gave a better response to Mexico's needs and fitted more properly to the reality of the country: the spectrum of provided activity categories and the range of emission factors allowed a better and more "realistic" estimation of the PCDD/PCDF releases. Therefore, further discussion will be focused on the results obtained through application of the Toolkit.

Application of the UNEP methodology to estimate the total releases of PCDD/PCDF in Mexico resulted in much higher releases than those found in the first Mexican inventory, when the US-EPA emission factors were used. For the year 2000, an annual release of 3,653 g TEQ was estimated with the Toolkit, which is more than seven-fold higher than the EPA estimate of 461 g TEQ (Table 1). Although the total release differs by one order of magnitude, it is important to underline that both estimations pointed to the same four most important sources: agricultural residues burning, uncontrolled combustion in waste open landfills, industrial waste incineration, and domestic waste burning.

Of the total amount of PCDD/PCDF releases in the country according to the UNEP Toolkit, agricultural residues burning is the most important source, with 1,163 g TEQ emitted to air, equivalent to 32 % of the total release. In a second place, uncontrolled combustion of wastes in open landfill contribute with 23 % of the releases, an equivalent of 825 g TEQ, a very important environmental risk issue according to some studies in countries with similar conditions⁹. Industrial waste incineration emitted almost 725 g TEQ, nearly 20 % of the total amount released, a similar percentage than other development countries inventories^{4,10}. Domestic waste burning is the fourth source, almost as high as the last mentioned activity, with 18 % of the release, equivalent to nearly 667 g TEQ. This result is in contrast to some studies that mention this activity as the most important^{7,11,12}. Together, these four activities represent 93 % of the total releases estimated. Forest fires, an activity mentioned as "high contributor" to the PCDD/PCDF emissions by other inventories^{6,13} did come out as a very important release source, when compared with the main four categories mentioned above.

Whereas international methodologies that are available have been created for evaluation of impacts on single environmental media, the UNEP Toolkit provides a methodology and associated emission factors for PCDD/PCDF releases to several media (air, water, soil, products, residues). This broader approach identified the atmosphere as the most important receiver of the PCDD/PCDF releases in Mexico with 56.9 %, followed by soil and residues, accounting for 18.4 % and 10.7% of the total amount, respectively. A summary of all releases by media is shown in Table 2. Uncontrolled combustion processes and waste incineration were identified as the most important contributors to the atmosphere releases.

Table 1: Release of PCDD/PCDF in Mexico for the year 2000, estimated using the EPA and UNEP Toolkit emission factors

Activity	RELEASE (g TEQ)		PERCENTAGE		RANK	
	USEPA	UNEP	USEPA	UNEP	USEPA	UNEP
Forest fires	1.85	49.2	0.40	1.35	7	6
Agricultural residues burning	222	1163	48.1	31.8	1	1
Medical waste incineration	5.27	33.6	1.14	0.92	5	7
Industrial waste incineration	0.84	725	0.18	19.5	8	3
Domestic waste burning	104	667	22.5	18.3	3	4
Uncontrolled combustion in WOL*	115	825	25.1	22.6	2	2
Biogas burning	0.154	0.005	0.03	0.00	12	13
Uncontrolled combustion of tires	0.060	0.256	0.01	0.01	13	12
Brick production plants	0.460	0.887	0.10	0.02	11	11
Cement industry	7.71	4.18	1.67	0.11	4	8
Metallurgy industry	0.81	181	0.17	4.95	9	5
Pulp and paper industry	0.74	1.34	0.16	0.04	10	10
PVC/CM Production	2.40	2.66	0.52	0.07	6	9
Total Releases	461	3,653	100	100		

* Waste open landfill

Table 2. Releases of PCDD/PCDF to each medium in Mexico for the year 2000, estimated using the UNEP emission factors

Activity	ANNUAL RELEASES (g TEQ)				
	AIR	WATER	SOIL	PRODUCTS	RESIDUES
Waste incineration	522				237
Ferrous and non-ferrous metal production	30.2				151
Power generation and heating	0.005				
Mineral products	4.99				0.08
Transport					
Uncontrolled combustion processes	1,524		671		
Production and use of chemicals and consumer goods		1.12		0.89	2.00
Total Releases	2,082	1.1	671	0.9	389

Overall, the UNEP Toolkit was identified as an applicable instrument, more flexible and easy to adapt to the needs of Mexico. It served to identify the most relevant sources of PCDD/PCDF releases in the country, providing a wider spectrum of sub-categories and technology classification which served to manage the statistical data in an easier way. While some gaps are still needed to be filled, mostly concerning the generation of data from developing countries and countries with economies in transition, which sometimes have technologies and processes that are very different from those where emission factors were obtained, there is a need to harmonize the different national inventories. For Mexico, which has ratified an international agreement, such as the Stockholm Convention on Persistent Organic Pollutants, the UNEP Toolkit provides an acceptable compromise to update and complete the current inventories. The PCDD/PCDF inventory will be done simultaneously within the framework of the NACEC Dioxins, Furans and Hexachlorobenzene North American Regional Action Plan, to allow comparability of the results among Mexico, Canada and United States.

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