

OPEN BURNING OF BIOMASS AND WASTE - AN IMPORTANT SOURCE OF PCDD/PCDF

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Introduction

The Stockholm Convention on Persistent Organic Pollutants (POPs) was adopted in 2001 and entered into force on 17 May 2004. Presently, the Convention has 172 Parties (1,2). For these, the development and maintenance of a release inventory for unintentional POPs, *i.e.*, polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans (PCDD/PCDF), is an obligation under article 5 of the Convention. Further, these inventories should be included in the National Implementation Plans (NIP) according to article 7 and the National Reporting according to article 15. The parties must transmit the NIP two years of the Convention enters into force for them, and afterwards, periodically update the plans.

In order to assist countries in the development of PCDD/PCDF inventories, UNEP Chemicals Branch has developed the “Standardised Toolkit for Identification and Quantification of Dioxin and Furan Release”(3). In order to improve the quality and the usefulness of the Toolkit, the Conference of the Parties – since its second meeting in 2006 - has established an open and transparent process to update and review the Toolkit, jointly led by the Secretariat of the Stockholm Convention and UNEP Chemicals.

Initial inventories have shown that open burning of biomass, such as forest, bush and grassland fires, burns in agriculture, and of waste are major sources of PCDD/PCDF in developing countries (4). Among the ten categories, category 6 = Open burning contributes with an average of 61% to the total TEQ of all emissions to air; second is category 1-mainly incineration of medical waste with approximately 12% and third is Category 3 = energy conversion and heating/cooking with approximately 7%. When PCDD/PCDF release inventories are compared, a hierarchical cluster analysis shows that Category 6, Open Burning, makes the difference between all inventories (see Figure 1).

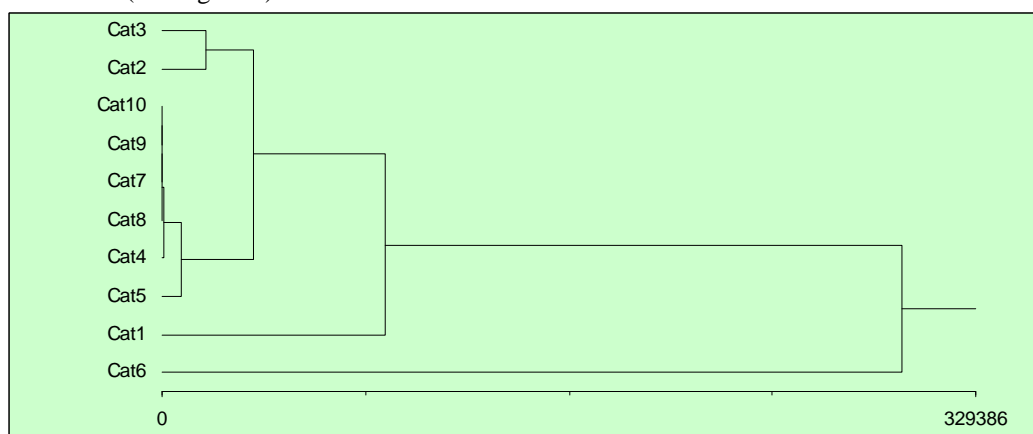


Figure 1: Dendrogram of the ten Categories in the UNEP Toolkit applied to 60 PCDD/PCDF inventories demonstrating similarities and dissimilarities

In order to assess the issue of open burning (corresponding to Category 6 in the UNEP Toolkit) in more detail, an internship work was mandated by UNEP's Division of GEF Cooperation (DGEF) in collaboration with UNEP Chemicals in fall 2010.

Materials and methods

The basis for the assessment consisted of a review of the NIPs, which were available either from the POPs WebPage or in hardcopy from the Stockholm Convention Secretariat or UNEP. Further, a questionnaire – in English, French - was developed and sent electronically to the POPs Focal Points or NIP coordinators, respectively. Most of the information was gathered through e-mail. The inventories – following the UNEP Toolkit 10-Category and 5-Vector approach – were stored in MsExcel® and further assessed with the same programme; statistical analysis was undertaken using StatistiXL (Microsoft).

Consistent with the Toolkit methodology, the questionnaire included a table to report the annual releases from Category 6, namely from open burning of biomass and waste/accidents. The table contained the structure and the emission factors of 2005 to obtain estimates as to the releases of PCDD/PCDF of biomass and waste according to the release vectors air and land. Other release vectors, such as water and product, were not applicable to the open burning processes and release to residues as ashes is considered as release to land since after the burns, the ashes are left on the ground and contaminate the soil rather than being collected and managed as solid residues or ashes.

Results and discussion

Filled questionnaires were returned to UNEP between 20 September 2010 and 30 November 2010 from 44 countries corresponding to a response rate of 35%; of these, three countries were not yet party to the Stockholm Convention but had already submitted their NIPs (Haiti, Malaysia and Montenegro). Of the 44 responses, Chad was excluded because its results were far too high; Mexico was not included because the table contained ranges and no central estimates; Moldova was not taken into account because they reported total releases; the information from Mozambique, Sierra Leone, and Slovenia did not contain quantitative data. For the responses, no common reference year could be identified; it is assumed that the inventories center between 2005 and 2008.

From the list of countries that had developed quantitative release data according to the Toolkit reporting format and responded to the questionnaire it can be seen that they were mainly from developing countries (Table 2). This can be explained that in general, developed countries did not use the Toolkit methodology nor format to develop and report their dioxin inventories; except for Mexico, New Zealand and Slovenia.

A total of 41 countries reported their releases of PCDD/PCDF – in g TEQ per year - to Air and Land for the open burning of biomass and waste (Table 2). The total releases were 18,363 g TEQ and reference year, whereby 8,958 g TEQ were emitted to air and 9,405 g TEQ to land. Considering the contribution from Sub-categories 6a and 6b, 4,610 g TEQ were from biomass burnings and 13,753 g TEQ from waste burnings or accidents. Noteworthy is that nine countries reported zero for releases from biomass (Guatemala, Pakistan, Tajikistan) or waste burnings (Bolivia, Cameroon, China, Honduras, Montenegro, Ukraine, Venezuela), respectively. Besides the difficulties to quantify the amount of material consumed in annual fires or doubts on the applicability of the emission factors, legal implications maybe the driver for setting annual emissions to zero.

Table 1: Summary of descriptive statistics for the assessment of annual releases of PCDD/PCDF (expressed as g TEQ/yr) from open burning of biomass and waste (categories 6a and 6b of the UNEP Toolkit)

| | Biomass _{Air} | Biomass _{Land} | Waste _{Air} | Waste _{Land} |
|-----------------------------|------------------------|-------------------------|----------------------|-----------------------|
| Mean | 24% | 16% | 32% | 29% |
| Median | 9% | 5% | 32% | 34% |
| Std Dev. | 29% | 23% | 28% | 26% |
| Variance | 8% | 5% | 8% | 7% |
| 25 th Percentile | 1% | 0% | 1% | 0% |
| 75 th Percentile | 56% | 28% | 48% | 52% |

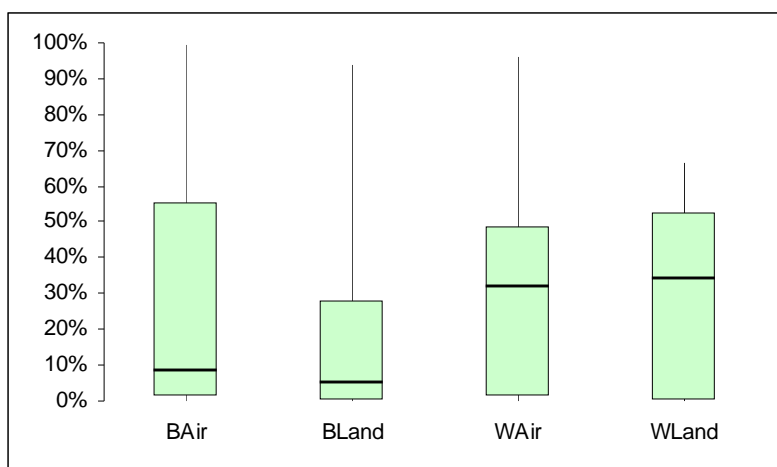


Figure 2: Frequency distribution of annual releases of PCDD/PCDF (in g TEQ per year) according to the fuel - biomass (B) or waste (W), respectively - and the release vector - air or land, respectively

From the above, the following preliminary conclusions can be drawn:

- The UNEP Toolkit is a useful tool to report release inventories for PCDD/PCDF in a harmonized manner that will allow for further assessments;
- However, not all countries/parties - and especially those from developed countries or those that report under the UNECE LRTAP Convention - use this format and therefore, they cannot be included in such assessments;
- It is recommended to use the Toolkit format to present the present release estimates and also use the same format for the future release inventories;
- Using the Toolkit 2005 emission factors for open burning releases, the contribution from sub-category 6b = Open burning of waste/accidents is larger than from open burning of biomass. However, either one can be the dominating source in any country;
- Since Open burning of sugarcane was not present as an own class with specific emission factors, the contribution from this activity to the overall national emissions could not be estimated.

Acknowledgements

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References

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4. Fiedler H. (2007): Chemosphere. 67:S96-S108, and presentations at the annual Toolkit Expert Group meetings <http://chm.pops.int/Overview/tabid/372/language/en-US/Default.aspx>

Table 2: Summary of annual releases of PCDD/PCDF (expressed as g TEQ/yr) from open burning of biomass and waste (categories 6a and 6b of the UNEP Toolkit)

| | Biomass | | | Waste | | | Total Releases | | |
|-----------------|---------|--------|-------|-------|-------|--------|----------------|------------|-------------|
| | Air | Land | Total | Air | Land | Total | Total Air | Total Land | Grand Total |
| Argentina | 203 | 162 | 365 | 353 | 706.5 | 1,060 | 556 | 869 | 1,424 |
| Belarus | 0.12 | 1.06 | 1.2 | 0.04 | 0.008 | 0.1 | 0.2 | 1.1 | 1.2 |
| Bolivia | 399 | 133 | 533 | 0 | 0 | 0 | 399 | 133 | 533 |
| Cameroon | 457 | 365 | 822 | 0 | 0 | 0 | 457 | 365 | 822 |
| Chile | 13.5 | 15.8 | 29.3 | 4.40 | 4.37 | 8.8 | 18 | 20 | 38 |
| China | 63.5 | 953 | 1,017 | 0 | 0 | 0 | 63 | 953 | 1,017 |
| Costa Rica | 58.1 | 19.6 | 78 | 93.0 | 91.0 | 184 | 151 | 111 | 262 |
| Côte d'Ivoire | 7.50 | 6.00 | 14 | 220 | 0 | 220 | 228 | 6.0 | 234 |
| Croatia | 0.002 | 0.002 | 0.004 | 0 | 0 | 0 | 0.002 | 0.002 | 0.004 |
| Cuba | 8.67 | 3.70 | 12 | 39.7 | 24.1 | 64 | 48 | 28 | 76 |
| Dominican Rep. | 64.5 | 21.5 | 86 | 0.34 | 0.62 | 1.0 | 65 | 22 | 87 |
| Guatemala | 0 | 0 | 0 | 327 | 196 | 524 | 327 | 196 | 524 |
| Haiti | 43.5 | 14.5 | 58 | 0.04 | 0.03 | 0.1 | 44 | 15 | 58 |
| Honduras | 21.2 | 12.5 | 34 | 0 | 0 | 0 | 21 | 13 | 34 |
| Iran | 95.3 | 31.8 | 127 | 706 | 0 | 706 | 802 | 32 | 833 |
| Jordan | 0.18 | 0.07 | 0.3 | 51.0 | 1.88 | 53 | 51 | 2.0 | 53 |
| Liberia | 22.5 | 7.5 | 30 | 160 | 180 | 340 | 183 | 188 | 370 |
| Lithuania | 0.86 | 0.3 | 1.2 | 12.9 | 13.0 | 26 | 14 | 13 | 27 |
| Morocco | 0.28 | 0.22 | 0.5 | 135 | 30.0 | 165 | 135 | 30 | 166 |
| Mauritius | 0.09 | 0.33 | 0.4 | 1.98 | 3.06 | 5.0 | 2.1 | 3.4 | 5.5 |
| Mongolia | 0.04 | 0.03 | 0.1 | 17.4 | 34.9 | 52 | 17 | 35 | 52 |
| Montenegro | 0.02 | 0.0001 | 0.002 | 0 | 0 | 0 | 0.02 | 0.0001 | 0.02 |
| Nicaragua | 6.42 | 3.10 | 10 | 166 | 300 | 466 | 172 | 303 | 476 |
| Nigeria | 152 | 121 | 273 | 2,600 | 2,400 | 5,000 | 2,752 | 2,521 | 5,273 |
| Pakistan | 0 | 0 | 0 | 313 | 626 | 940 | 313 | 626 | 940 |
| Paraguay | 22.4 | 8.50 | 31 | 38.7 | 76.2 | 115 | 61 | 85 | 146 |
| Peru | 115 | 61.5 | 177 | 2.79 | 3.44 | 6.2 | 118 | 65 | 183 |
| Russia | 172 | 137 | 309 | 420 | 1,260 | 1,680 | 592 | 1,397 | 1,989 |
| Rwanda | 1.13 | 1.85 | 3.0 | 45.5 | 25.3 | 71 | 47 | 27 | 74 |
| Seychelles | 0.001 | 0.003 | 0.004 | 0.38 | 0.74 | 1.1 | 0.4 | 0.7 | 1.1 |
| Serbia | 0.15 | 0.12 | 0.3 | 84.1 | 94.0 | 178 | 84 | 94 | 178 |
| Syrian Arab Rep | 0.002 | 0.002 | 0.0 | 339 | 208 | 547 | 339 | 208 | 547 |
| Tajikistan | 0 | 0 | 0 | 3.97 | 7.42 | 11 | 4.0 | 7.4 | 11 |
| Tanzania | 227 | 181 | 408 | 124 | 48.1 | 172 | 351 | 230 | 580 |
| Thailand | 19.9 | 6.64 | 27 | 124 | 240 | 364 | 144 | 246 | 391 |
| Tonga | 0.04 | 0.03 | 0.1 | 20.4 | 14.4 | 35 | 20 | 14 | 35 |
| Uganda | 36.6 | 1.97 | 39 | 246 | 492 | 738 | 283 | 494 | 777 |
| Ukraine | 0.23 | 0.18 | 0.4 | 0 | 0 | 0 | 0.23 | 0.18 | 0.4 |
| Uruguay | 4.28 | 1.79 | 6.1 | 3.37 | 6.1 | 9.5 | 7.7 | 7.9 | 16 |
| Venezuela | 54.1 | 37.6 | 92 | 0 | 0 | 0 | 54 | 38 | 92 |
| Vietnam | 23.7 | 5.33 | 29 | 10.5 | 0 | 11 | 34 | 5.3 | 40 |
| Total | 2,292 | 2,317 | 4,610 | 6,666 | 7,088 | 13,753 | 8,958 | 9,405 | 18,363 |

