Webinar Report

Introduction to PCDDs/PCDFs and Unintentional POPs: Emission Control and Inventory Development

19 September 2024

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Introduction

This webinar marked the eighth session in a series of training activities organized by the Green Growth Knowledge Partnership (GGKP) under Component 4 (Knowledge Management and Information Sharing) of the GEF project ID 10785, titled *Global Development, Review and Update of National Implementation Plans (NIPs) under the Stockholm Convention (SC) on Persistent Organic Pollutants (POPs)*.

As part of ongoing knowledge-sharing efforts, this session focused on the formation, release and management of polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/PCDFs) and other unintentional POPs, including unintentional PCBs, PCNs, HCB, PeCB, and HCBD. The discussion emphasized the importance of developing robust inventories to identify, quantify, and prioritize sources of these pollutants, alongside strategies for their minimization and, where feasible, elimination.

The webinar also introduced the UNEP Toolkit methodology, which guides the development of comprehensive and comparable inventories of unintentional POPs (UPOPs). Additionally, participants explored the release of other pollutants from key Annex C sources, reinforcing the need for an integrated pollution prevention and control approach to manage UPOPs and other contaminants effectively .

CEST 15:00	1. Welcome and Opening Remarks
	Moderator: **Anastasiya Buchok**, Component 4, GGKP
	Speaker: **Dr. Roland Weber**; POPs Environmental Consulting
15:05	Part A: Introduction to PCDD/PCDFs and other unintentional POPs (unintentional PCBs, PCNs, HCB, PeCB and HCBD) and their formation and release from major sources.
15:40	Part B: Inventory development of PCDD/PCDF and other unintentional POPs releases with the UNEP Toolkit for Identification and Quantification of Releases of Dioxins, Furans, and Other Unintentional POPs under Article 5 of the Stockholm Convention (https://toolkit.pops.int/)
16:35	Part C: Integrated Approach for Pollution Prevention and Control (IPPC) of unintentional POPs and other major pollutants
16:50	Q&A session
17:00	Closing remarks

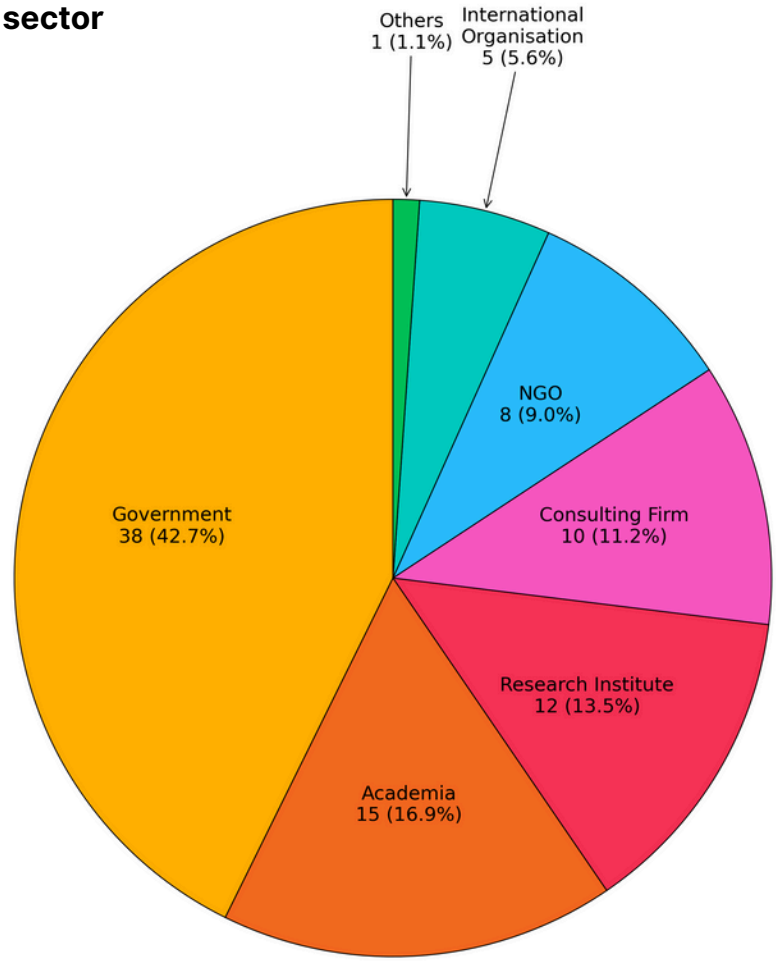
Registration and Attendance

Number of registrants: 146 / Total attendance: 89
(Approx. 46% female and 54% male)

Participants by country

Country	Attendees	Country	Attendees	Country	Attendees
Ethiopia	8	Uruguay	3	Guinea	1
North Macedonia	7	Bahamas	2	India	1
Senegal	6	Côte d'Ivoire	2	Kenya	1
Cameroon	5	Dominica	2	Republic of Korea	1
Albania	4	Germany	2	Maldives	1
Burundi	4	Kazakhstan	2	Montenegro	1
Togo	4	Myanmar	2	Seychelles	1
Armenia	3	Bolivia	1	Thailand	1
Madagascar	3	Brazil	1	Uganda	1
Peru	3	Cambodia	1	United States	1
South Africa	3	China	1	Zambia	1
Switzerland	3	Czech Republic	1	Zimbabwe	1
Trinidad and Tobago	3	Eswatini	1		

Participants by sector



Key Highlights

Unintentional Persistent Organic Pollutants (UPOPs) are hazardous by-products generated from industrial, thermal, and chemical processes, often released into the environment through incomplete combustion, open burning and certain manufacturing activities. These pollutants, listed under the Stockholm Convention, include dioxins, furans and other chlorinated compounds, which persist in the environment, bioaccumulate in the food chain, and pose severe risks to human health and ecosystems.

UPOPs listed in the Stockholm Convention

- Polychlorinated dibenzo-p-dioxins (PCDDs)
- Polychlorinated dibenzofurans (PCDFs)
- Polychlorinated biphenyls (PCBs; the main POPs amount was in Annex A)
- Hexachlorobenzene (HCB)
- Pentachlorobenzene (PeCBz)
- Polychlorinated naphtalenes (PCNs)
- Hexachlorobutadiene (HCBD)

Exposure to dioxins and other uPOPs poses significant health risks, with effects ranging from acute toxicity to long-term chronic diseases. Exposure can cause chloracne, a severe skin condition, and wasting syndrome, characterized by extreme weight loss and muscle deterioration. In extreme cases, particularly in industrial accidents or heavily contaminated environments, uPOPs can be fatal to both humans and animals. Long-term exposure to uPOPs has been linked to serious chronic health conditions, including cancer, endocrine disruption, and immune system suppression.

The most toxic dioxin, 2,3,7,8-TCDD, is classified as a known human carcinogen, capable of promoting tumor development. As endocrine disruptors, uPOPs interfere with hormonal balance, which can lead to metabolic disorders and reproductive health issues. This webinar also associated dioxin exposure with developmental toxicity, affecting fetal growth and early childhood development, as well as increased risks of diabetes and endometriosis. Additionally, uPOPs can weaken the immune system, reducing the body's ability to respond to infections and environmental stressors.

Human exposure to Dioxins/uPOPs and its link to pollution sources includes the following:

- Life-cycle of PCDD/PCDFs and other uPOPs
- PCDD/Fs in human milk
- Eggs as exposure pathway of PCDD/F & PCB from contaminated soil

UPOPs formation

UPOPs are unintentionally generated during combustion and chemical manufacturing processes. Key pathways include:

- Formation from precursors: PCBs and other chlorinated compounds can transform into PCDFs and PCDDs under certain conditions.
- Open burning and poor combustion practices: Inefficient burning of waste materials leads to significant PCDD/F emissions.
- Metal production and industrial processes: Smelting, refining and other metal processing activities release uPOPs.
- Incinerators and waste processing: Non-Best Available Techniques (BAT) incinerators produce high levels of dioxins and furans.
- Chlorinated solvent and organochlorine production: Industrial production of chlorinated chemicals also contributes to uPOP formation.

Key Highlights

PCDD/F & other uPOPs inventory development with the UNEP toolkit
National inventories of dioxin/uPOP sources are developed to identify, quantify and prioritize sources of releases. Stockholm Convention: "An evaluation of current and projected releases, including the development and maintenance of source inventories and release estimates, taking into consideration the source categories identified in Annex C." In this connection, the UNEP toolkit for identification and quantification of releases of dioxins, furans and other uPOPs was developed to assist Parties in establishing release inventories that are consistent in format and content, ensuring that it is possible to compare results, identify priorities, mark progress and follow changes over time at the country level, as well as regional/global level. This toolkit employs the Emission Factor Methodology for the identification and quantification of releases of PCDDs, PCDFs and other unintentionally produced POPs.

The webinar emphasized a five-step approach for the establishment of a PCDD/PCDF inventory considering the UNEP toolkit:

1. Use "Screening Matrix" as a guide to identify Source Groups present in the country.
2. Use the "Source Category" list to identify specific sources and activities in the country's respective Source Groups.
3. Obtain information on individual sources (activity rates; technology level) to classify these and select the emission factors.
4. Quantify identified sources by applying default/measured emission factors.
5. Apply nationwide to establish full inventory.

When using the UNEP toolkit, the following calculation methodology can be considered:

Calculation of source strength (dioxin release/year):
The basic principle is to gather "Activity Rates", which describe quantities of a process (e.g. tonnes incinerated; tonnes steel produced per year), and select "Emission Factors" (EF), which describe the release of uPOPs/pollutants to each medium per unit of activity (e.g. µg TEQ/tonne). Multiplying EF and Activity Rate yields annual releases of a Source (Source Strength).

Annual PCDD/PCDF emission estimate:
Source Strength (gram TEQ Dioxin emission per year) = **Emission Factor** x **Activity Rate** (1)
(Emission factor = amount PCDD/PCDF/uPOP per tonne of feed processed or product produced).
For a country or region: Total annual PCDD/PCDF release = Σ annual releases from all source groups and overall release vectors.

Activity rates (Amount/Flux from an activity per year: tonnes produced; amount waste burned; or m3 emitted):

- "non-dioxin-like"
- Country-specific
- Economic data, statistics, plant/facility data
- The data the task team will gather

Emission factors (gram TEQ dioxin/tonne product or; /m3):

- Identical tofor similar technology
- Default emission factors (provided in toolkit)
- But the team needs to gather information on individual plants like individual incinerators to decide what category of the toolkit to select.
- Own measured data (quality requirement)

Questions and Answers

Q1. The peak in dioxin concentration in sediments was in 1950-1970; then the concentration is decreased. Dioxins are highly persistent. So, this data means the dioxins that were present in the sediments in the 1950s-1960s got transferred to some other matrices or got destroyed. Can you provide more insights into how this lowering happened?

Dr. Roland Weber: The dioxins in the sediment layers from the 1950s to 1970s are still there. However,the top sediment layers from 1980 to 2020 have lower levels.So, if you do a dredging of sediments, these old PCDD/F and other POPs from the 1950s to 1970s are accessed and if spread on land or in the water are remobilized and can cause exposure.

Please see our review article which also has a section on sediments: *Weber R et al. (2018) Reviewing the relevance of dioxin and PCB sourcesfor food from animal origin and the need for their inventory, control, and management. Environ Sci Eur. 30:42.* https://rdcu.be/bax79.

Q2. How important is it to consider emission factors when conducting the inventory?

Dr. Roland Weber: The emission factors are very important since you need them to calculate and quantify emissions which is the basis to compare different sources and priorities.

Q3. What metal is the most efficient in the production of uPOPS furan and dioxins during incomplete combustion?

Dr. Roland Weber: Copper is the best catalyst for uPOPs formation in thermal processes including incomplete combustion. But also, iron is quite active as a catalyst.

Q4. What is the best available method for the disposal of PCB-contaminated oils from transformers?

Dr. Roland Weber: By far the largest share of PCBs was destroyed in hazardous waste incinerators. However, BAT hazardous waste incinerators are mainly available in high-income countries. Cement kilns are another option when feeding PCBs with the main burner it should also be destroyed (more than 99.9999%).

Q5. What temperatures are recommended for complete destruction of PCBs in an incinerator?

Dr. Roland Weber: Optimally, hazardous waste incinerators operate normally above 1100°C. If you have a stable incinerator, 1000°C might be also sufficient. I recommend continuous Dioxin/PCB monitoring for PCB destruction projects. *e.g. Reinmann J., Weber R., Haag R. Long-term monitoring of PCDD/PCDF and other unintentionally produced POPs – Concepts and case studies from Europe. Science in China - Chemistry 53, 1017-1024 (2010).*

Questions and Answers

Q6. How do we estimate the amount of uPOPs that are generated from open burning? What tools to use to determine which specific uPOPs are released to the environment?

Dr. Roland Weber: The UNEP toolkit has in Source Group 6 a list of Emission Factors for open burning you should consider for your inventory: https://toolkit.pops.int/Publish/Main/II_00_DefaultEF.html

Q7. Can we have an Excel version of the toolkit?

Dr. Roland Weber: Yes, you can download in different languages here: https://toolkit.pops.int/Publish/Main/Download.html

Q8. How do you determine the emission Factor for the other uPOPs than PCDD/F?

Dr. Roland Weber: As mentioned, some uPOPs emission factors are given in the UNEP toolkit in the annexes. Also, the PCN and the HCBD inventory guidance include some emission factors. For countries with monitoring capacity, you can also do measurements. There is also a range of publications where emission factors can be found.

Q9. May I ask if the emission-curbing structures such as scrubbers and other emission filtering technology employed at incineration facilities, if they are not effective enough to control the emission uPOPs?

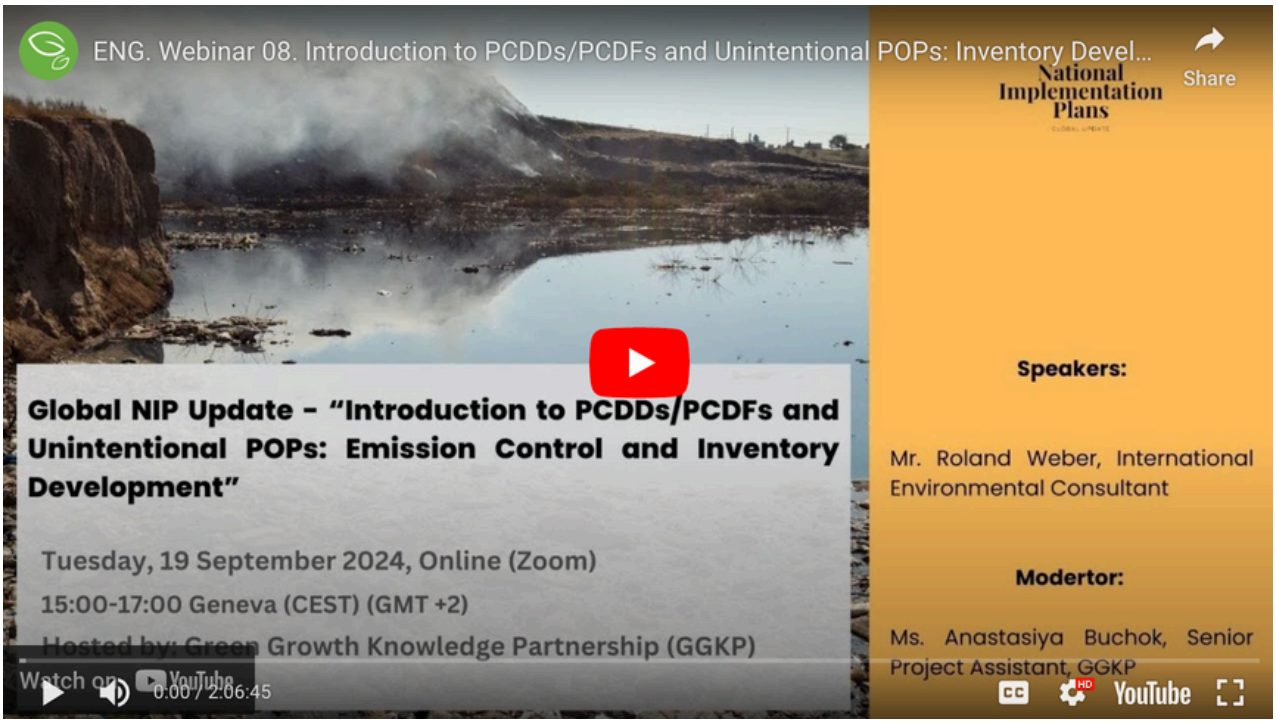
Dr. Roland Weber: Carbon spray and bag filters or wet scrubbers with adiox can be very efficient for uPOP emission control. But as highlighted also the ashes from the filters need to be managed in an environmentally sound manner and should not be disposed of in the environment. Please see the IPEN reports on toxic ashes from incinerators. Also, you can have a look at this review on POPs in eggs: *Petrlik J, Bell L, DiGangi J, et al & Weber R. (2022) Review: Monitoring of Dioxins and PCB in Eggs as Sensitive Indicator for Environmental Pollution and Contaminated Sites and Recommendations for Reducing and Controlling Releases and Exposure. Emerg. Contam. 8, 254-279 https://doi.org /10.1016/j.emcon.2022.05.001*

Q10. How do you evaluate the emission rate for municipal waste open burning in low-income countries? In some periods part of surface disposal is burned, can we use satellite images?

Dr. Roland Weber: You need to estimate the amount of waste burnt. Satellite data can help. One easier approach is to use the total amount of waste generatedand then do an estimate of how much percent of this waste is openly burned in landfills (there is an emission factor) or in backyards/streets (there is another emission factor); e.g. rather 10% or rather 50% or even more?

Resources

- **A concept note and video recording in English, Spanish, French and Russian of the webinar are available on the Global NIP Update platform:** https://www.greenpolicyplatform.org/webinar/introduction-pcddspcdfs-and-unintentional-pops-emission-control-and-inventory-development



Spanish | French | Russian

- **PCDD/F formation in open burning – effect of organic chlorine**
  - Ikeguchi, T. and Tanake, M. (1999) 'Experimental study on dioxins emission from open burning simulation of selected wastes', Organohalogen Compounds 41, 507-510. https://dioxin20xx.org/wp-content/uploads/pdfs/1999/99-237.pdf

- **Life-cycle of PCDD/PCDFs and other uPOPs**
  - Weber, R. et al. (2018) 'Reviewing the relevance of dioxin and PCB sources for food from animal origin and the need for their inventory, control and management', Environmental Sciences Europe, 30(1). https://rdcu.be/bax79

- **PCDD/Fs in human milk (UNEP/WHO survey)**
  - WHO. Breastfeeding. https://www.who.int/health-topics/breastfeeding#tab=tab_1
  - Mead, M.N. (2008) 'Contaminants in Human Milk: Weighing the Risks against the Benefits of Breastfeeding', Environmental Health Perspectives, 116(10), pp. A426–A434. https://pmc.ncbi.nlm.nih.gov/articles/PMC2569122/
  - Malisch, R., Fürst, P. and Šebková, K. (2023) Persistent Organic Pollutants in Human Milk. Springer. https://link.springer.com/book/10.1007/978-3-031-34087-1

Resources

- **Eggs as exposure pathway of PCDD/F & PCB from contaminated soil**
  - Petrlik et al. (2022) 'Monitoring dioxins and PCBs in eggs as sensitive indicators for environmental pollution and global contaminated sites and recommendations for reducing and controlling releases and exposure'. Emerging Contaminants, 8, 254-279. https://doi.org/10.1016/j.emcon.2022.05.001

- **Updated toolkit for identification and quantification of releases of dioxins, furans and other unintentional POPs**
  - https://toolkit.pops.int/

- **Updating dioxin/uPOPs inventory and establishing trends in release**
  - Stockholm Convention Training Tool on the Technical Guidelines for the Environmentally Sound Management (ESM) of Persistent Organic Pollutants (POPs) wastes https://www.greenpolicyplatform.org/course/stockholm-convention-training-tool-technical-guidelines-environmentally-sound-management-esm

- **Contaminated sites/hotspots**
  - Draft guidance on identification and management of sites contaminated with persistent organic pollutants https://chm.pops.int/Implementation/BATandBEP/POPscontaminatedsites/Guidance/tabid/9649/Default.aspx
  - Weber, R. et al. (2008) 'Dioxin- and POP-contaminated sites—contemporary and future relevance and challenges', Environmental Science and Pollution Research, 15(5), pp. 363–393. https://link.springer.com/article/10.1065/espr2008.01.473#page-1
  - Weber, R., Aliyeva, G. and Vijgen, J. (2013) 'The need for an integrated approach to the global challenge of POPs management', Environmental Science and Pollution Research, 20(4), pp. 1901–1906. https://link.springer.com/content/pdf/10.1007/s11356-012-1247-8.pdf

- **Stockholm Convention BAT/BEP guidance on unintentional POPs**
  - https://www.greenpolicyplatform.org/guidance/guidelines-best-available-techniques-and-provisional-guidance-best-environmental-practices

- **European Union integrating pollution prevention and control (IPPC) and Stockholm Convention BAT/BEP**
  - https://eippcb.jrc.ec.europa.eu/reference

If you have any questions or comments, please contact the GGKP team.

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