

Concentrations of Unintentional POPs in Soils and Ashes from Benin, Africa

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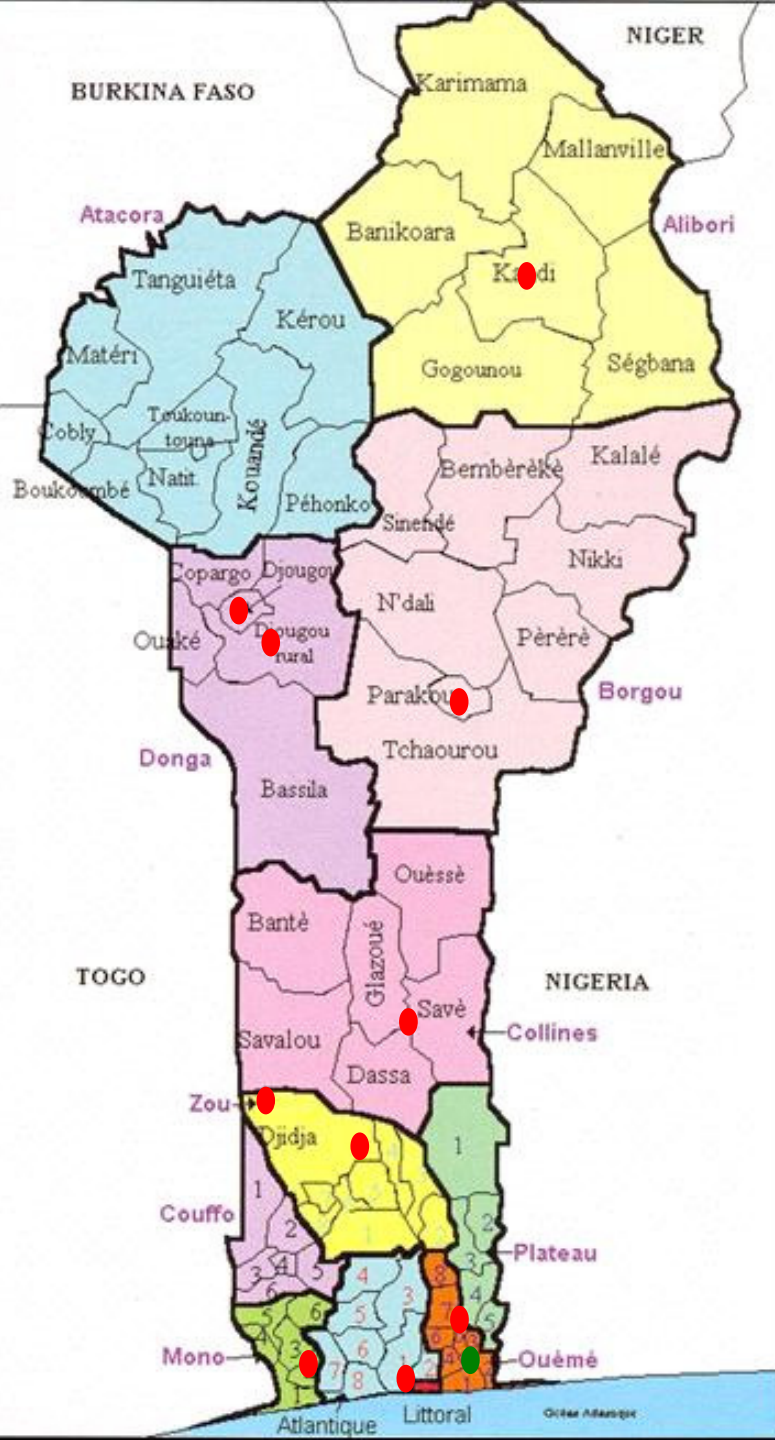
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International Context

- **Stockholm Convention in Annex C lists PCDD, PCDF, PCB, and HCB as unintentional POPs;**
- **Article 5 of the Convention requires that Parties shall take measures for "continuing minimization, and where feasible, ultimate elimination" of total releases of these POPs;**
- **UNEP published the Standardized Toolkit for developing PCDD/PCDF inventories when no measured data are available;**
- **No PCDD/PCDF results from Sub-Saharan African countries available;**
- **First orientation as to the presence of PCDD/PCDF in the African environment and from combustion sources (complementary to a stack sampling project in Cameroon).**

Benin Context

- **Benin ratified the Stockholm Convention on Persistent Organic Pollutants on 5 January 2004;**
- **Benin has not yet submitted the national implementation plan (NIP; due 16 May 2006);**
- **Within the frame of their NIP development and additional funding from the Canada POPs Fund, the Republic of Bénin jointly with UNEP Chemicals implemented this project to collect soil and ash samples and analyzed them for unintentional POPs (PCDD, PCDF, PCB, and HCB);**
- **The dioxin laboratory was selected through an open tender;**
- **Results of this first survey will feed into Benin's NIP and give first indication of unintentional POPs pollution in a Sub-Saharan African country**



Bénin is located in Western Africa;

Located: 9° 30' N, 2° 15' E;

Total area: 112,620 km²

Border countries:

Burkina Faso 306 km,

Niger 266 km,

Nigeria 773 km,

Togo 644 km;

Population: 7,862,944 (2006)

Soil samples ●

Ash samples ●

Materials and Methods (1)

- **Soil and ash sampling protocols developed;**
- **Soil samples were from sites potentially polluted by local industries and domestic activities;**
- **Soil samples were composites of 5 discrete pick-ups per site, 10 cm depth, mixed in a steel bowl, placed into sampling jars; All had inputs from discharges like waste or wastewater;**
- **Ash samples were from domestic cooking places, from burning of municipal solid waste and biomedical waste burned in non-specialized furnaces, from open agricultural burning, and from small informal industries;**
- **Each sample consisted of three sub-samples of bottom ash taken after one day of normal activity. Unburned and interfering material removed.**

Materials and Methods (2)

- **Glass jars were wrapped in aluminum foil, labelled, and express-shipped for analysis to GfA eurofins, Münster-Roxel, Germany;**
- **Analytes:**
PCDD/PCDF and dl-PCB
PCB₇ (#28, 52, 101, 118, 138, 153, and 180) and HCB
- **Dioxin analysis was done according to EPA 1613;**
- **Results for PCDD/PCDF and dl-PCB are presented in WHO₁₉₉₇-TEQ/kg d.m. and as upper-bound concentrations;**
- **Some soil samples could not be analyzed.**

Soil Samples

Description (ng TEQ/kg)	d.m.	PCDD/PCDF (ng TEQ/kg)	dl-PCB (ng TEQ/kg)	PCB (ng/kg)	HCB (µg/kg)
Disposal of municipal waste	84.8%	0.53*	0.26*	0.47*	2.50*
Disposal of municipal waste	89.2%	0.50	0.27	0.62	2.50*
Disposal of municipal waste	76.9%	2.76			2.50*
Disposal of wood waste	75.8%	0.15*	0.28*	0.50*	2.50*
Contaminated with used oil	82.2%	95.4			2.50*
Contaminated from cotton industry	94.1%	0.47	0.27	0.85	2.50*
Impact from fish smoking	80.5%	2.64			2.50*
Contaminated after spraying of sludge	88.4%	1.37			2.50*
Contaminated with wastewater from CODA	84.7%	1.30			2.50*
Contaminated with phyto- pharmaceuticals	86.1%	1.02			2.50

Ash Samples (1)

Description (ng TEQ/kg)	d.m.	PCDD/PCDF (ng TEQ/kg)	dl-PCB (ng TEQ/kg)	PCB (ng/kg)	HCB (µg/kg)
Ash domestic cooking	100%	0.46*	2.3	0.2*	0.50*
Ash domestic cooking	99%	0.45*	0.22*	0.2*	0.50*
Ash domestic cooking	100%	0.45*	0.22*	0.5*	0.50*
Ash domestic cooking	99%	0.58	0.22*	0.5*	0.50*
Ash domestic cooking	95%	0.80	0.23*	0.5*	0.50*
Ash domestic cooking	100%	0.58	0.22*	0.5	0.50*
Ash domestic cooking	100%	0.61	0.22*	0.5*	0.50*
Ash domestic cooking	100%	0.45*	0.22*	0.5*	0.50*
Ash, smoking of fish	100%	3.58	0.21*	0.5	0.50*
Ash, smoking of fish	100%	0.99	0.22*	0.5*	
Ash, burning of domestic waste	97%	1.21	0.22	0.2*	0.50*
Ash, burning of domestic waste	99%	0.46	0.24*	0.5*	0.50*
Ash, burning of domestic waste	97%	2.53	0.32	0.6	0.50*
Ash, burning of domestic waste	98%	0.56	0.22	0.6	0.50*

Ash Samples (2)

Description (ng TEQ/kg)	d.m.	PCDD/PCDF (ng TEQ/kg)	dl-PCB (ng TEQ/kg)	PCB (ng/kg)	HCB (µg/kg)
Ash, biomedical waste incin.	95%	188	7.85	0.5	1.30
Ash, biomedical waste incin.	98%	264	10.8	0.5	2.09
Ash, biomedical waste incin.	100%	0.52*	0.22*	0.5*	0.50*
Ash, local industry					
(burning of sawdust)	94%	1.01	0.27*	0.6*	0.50*
Ash, local industry (cotton)	100%	0.43*	0.21*	0.5*	0.50*
Ash, local industry					
(fusion of aluminum)	99%	249	3.57	1.23	
Ash, bushfire	99%	0.54	0.22*	0.5	0.50*
Ash, burning of corn in field	98%	0.46	0.23*	0.5*	0.50*
Ash, burning of yam in field	100%	91.1	3.36	0.7	1.93

* No congener quantifiable

Results – HCB and PCB₇

- **33 Samples analyzed (soil – 10, ashes – 23);**
- **“low POP content” at 50 mg POP/kg for each of the POPs pesticides and PCB¹;**
- **HCB quantified only in 4 of the 33 samples, Concentrations always close to detection limit, Maximum at 2.09 µg/kg, ash biomedical waste;**
- **PCB₇ in general low, One ash from aluminium fusion had 1.23 µg/kg;**
- **HCB and PCB concentrations far below low POP content.**

¹ Technical Guidelines for Basel and Stockholm Conventions

Results – PCDD/PCDF

- **PCDD/PCDF** in general very low
- In soil: Range was 0.15-2.64 ng WHO₁₉₉₇-TEQ/kg d.m.;
- One soil sample with visible contamination by used oil had 95.4 ng WHO-TEQ/kg d.m. (no PCB analysis possible);
- In ash (19): range was 0.43-3.58 ng WHO-TEQ/kg;
Higher concentrations in:
 - **Biomedical waste incineration:** 188 and 264 ng TEQ/kg
 - **Aluminium fusion:** 249 ng TEQ/kg
 - **Burning of yam in the field:** 91.1 ng TEQ/kg
(whereas burning in cotton and corn were ~0.5 ng TEQ/kg).

Soil Concentrations in Perspective

	ng TEQ/kg	Comment
Benin	0.5-2.6	Typical range
	95.4	Maximum, contaminated oil
For orientation:		
Germany	< 5	Target concentration
	5-40	Control of products if dioxin transfer may occur
	>100	Soil exchange on children playgrounds
	>1,000	Soil exchange in residential areas
	>10,000	Soil exchange independently of location
Low POP	>15,000	Classification as “hazardous waste”

Ash Concentrations in Perspective

ng TEQ/kg Comment

Benin	0.43-3.58	Typical range
	188-264	High end (medical waste incin., Al ind.)
	91	Maximum in open field burning

For orientation:

Low POP	>15,000	Classification as “hazardous waste”
Toolkit	10 and 100	Grate ash in medical waste incinerators (medium, high-tech)
	1,500	Thailand measurement (medical waste)
	10 and 1,000	Natural and contaminated wood stoves
	200	Agricultural fires

Discussion PCDD/PCDF vs. dl-PCB

- dl-PCB hardly detected; high PCDD/PCDF samples had also highest dl-PCB: 3.36-10.8 ng TEQ/kg

Sample Type	ng TEQ/kg		%TEQ dl-PCB
	PCDD/PCDF	dl-PCB	
Ash, burning biomedical waste	188	7.85	4%
Ash, burning biomedical waste	264	10.8	4%
Ash, fusion of aluminum	249	3.57	1%

Conclusions (1)

- **Among the first PCDD/PCDF, PCB, and HCB data obtained from African environment;**
- **Serve as first orientation with respect to soil and bottom ashes;**
- **Perceived contamination sites often did not confirm presence of POPs and in general concentrations were low;**
- **Nine of the ten soil samples had very low concentrations when compared to datasets obtained elsewhere in Europe, North America or East Asia;**
- **The ash samples varied largely. They indicate that the use of typical fuels for domestic cooking and also the burning of “normal” domestic waste does not result in high unintentional POPs pollution in the solid residues;**
- **Cotton production does not seem to be associated with (high) unintentional POPs concentrations.**

Conclusions (2)

- **However, the soil sample contaminated with waste oil makes clear the need for identification of the contamination source and proper management of such waste;**
- **Burning of some local crops in the field have the potential to generate PCDD/PCDF/dl-PCB;**
- **Some artisanal activities could be identified that generated high concentrations in the bottom ashes (Al fusion);**
- **Need further investigation to better characterize the local situation and practices;**
- **Need to also attempt to sample and analyze flue gases from the combustion processes \Rightarrow to finally improve the Toolkit and feed African data into the database.**

Acknowledgement

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- **The cooperation of the sampling team and the owners of the ovens in Benin are highly acknowledged.**