Selected POPs waste „Hot Spots“ around the World

Klatovy-Luby, Czech Republic
An example of a former pesticide storage site which is still contaminated with high levels of DDT and other OCPs.

German salt mines
Salt mines in Germany are used to store POPs however there have been several leaks and a particularly high profile scandal over the past years has been caused by the leakage of radioactive waste from the Asse II mine.
POPs-F · PCDD/F · HCB

Giessen, Germany
Dioxin-contaminated slag was used as a covering material for sport ground in Giessen.
POPs-F

Lampertice, Czech Republic
Site was used for preparation of mixture of wastes including waste incineration residues, metallurgy residues and sewage sludge from chemical plants.
POPs-F · PCDD/F · HCB

Belaruchi, Belarus
Dioxin contaminated 'construction' material is stored in a dilapidated and partly demolished storage buildings near the village.
POPs-F

Chapaevsk, Russia
Chapaevsk is one of the most polluted towns in Russia.
POPs-F

Ust-Kamenogorsk, Kazakhstan
Very large quantities of PCBs from the waste ponid are leached to the Irtysh River via groundwater pathways.
PCB

Dzerzhinsk, Russia
Has high levels of POPs contamination from a variety of different sources.
POPs-F · PCDD/F · DDT

Karabash city and Tobolsk city, Russia
Elevated levels of dioxin have been found in breast milk in this heavily industrialised area which included a former copper smelting facility.
POPs-F · PCDD/F

Wingmoor farm, UK
Incinerator air pollution control residues from around the UK are 'treated' on site by mixing with leachate or contaminated water and are left for long periods in open cells.
POPs-F

Sydney, Canada
The Sydney Tar Ponds contain approximately 700,000 tonnes of highly contaminated sediments.
PCB

Rouyn-Noranda, Canada
The chemical reaction between the chlorine and carbon in this magnesium smelting plant resulted in a cocktail of organochlorine POPs.
POPs-F · HCB

Saginaw and Tittabawassee Rivers, Michigan, USA
Very high levels of dioxin contamination were caused by historical discharges from the chemical works and incinerators operated by Dow Chemical.
POPs-F

Hamilton, Canada
More than 400 tonnes of PVC were burned in a fire at Plastimet, Inc.
POPs-F

Wittelsheim, France
This potash-salt mine in Wittelsheim was the first underground landfill in France and was used for the disposal of was wide range of wastes include galvanising sludge, spent catalysts, and residues from waste incineration.
POPs-F · PCDD/F · HCB

Puto, Croatia
There are still at least 250 tons of ash dumped around the site of this former hazardous waste incinerator.
POPs-F · PCDD/F

Izmit, Turkey
The sludge and ashes resulting from the waste incineration facility and are being disposed to a landfill.
POPs-F · PCDD/F · HCB

Balad, Iraq
A large open burn pit is typical of many in Iraq and Afghanistan where military wastes are burned in the open causing what the US authorities describe as a "chronic and acute health hazard to our troops and the local population."
POPs-F · HCB

Peshawar, Pakistan
Ashes from the incineration of medical waste are dumped around the site and in wells in spite of their high levels of dioxin.
POPs-F · PCDD/F · HCB

Nose Town, Japan
Approximately 11,000 tons of dioxins contaminated soil had been dumped near the municipal waste incinerator.
POPs-F

Teshima Island, Japan
Industrial waste was illegally dumped into a 30 ha gravel pit site on Teshima Island.
PCDD/F

Da Nang, Bien Hoa, and Phu Cat, Vietnam
High level of dioxin contamination was caused by the spillage of highly toxic 'Agent Orange' defoliant.
POPs-F

AnShun, Taiwan
Local soil and fish samples are both highly contaminated with dioxins from this now closed chemical works.
POPs-F

Guiyu, China
The main electronic waste recycling area in China with possibly the highest levels of dioxins amongst all hotspots. Very high levels of heavy metals, PBDEs and brominated dioxins are also reported.
POPs-F

Lake Charles/Calcasieu Estuary, Luisiana, USA
At least 120,000 tons of dioxin-contaminated wastes was dumped into the bayou.
POPs-F · PCDD/F · HCB

Mbeubeuss, Senegal
A wide range of chemical and hazardous wastes, some contaminated with pentachlorophenol and PCDD/Fs are dumped here .
POPs-F · PCDD/F · HCB

Lome, Togo
Incinerator ash residues are spread on the ground where they could contaminate crops.
POPs-F

Luwero and Nakasongola, Uganda
Incinerator ash residues are buried in a pit within a barracks area.
POPs-F

Kitengela / Athi River, Kenya
Hazardous waste incineration residues are tipped in a residential area without any containment and present a high risk of environmental contamination.
POPs-F · PCDD/F · HCB

Eloor, India
The plant produces DDT and other organochlorine pesticides. High levels of emissions and discharges have caused widespread contamination.
DDT · OCPs · POPs-F

Old Korogwe, Tanzania
After removing stocks of DDT, highly DDT contaminated soil remains around the site.
DDT

Vanderbijlpark, South Africa
A large dumpsite for wastes, some of which are contaminated with POPs, from nearby iron and steel manufacturing plant.
POPs-F · PCDD/F · HCB

Phuket, Thailand
Bottom ash/clinker and fly ash from these operations has been dumped or stored in ash pits and also local mangrove swamps.
POPs-F · PCDD/F

El Zapallal, Peru
Ash from incinerators and illegal smelting activities is dumped here.
POPs-F

Santiago del Estero, Argentina
This pesticide dump is only 150 m from a school.
HCB · DDT · OCPs

Cidade dos Meninos, Brazil
When this Lindane factory closed piles of residues were left behind and caused widespread contamination of land and soil.
DDT · OCPs

Whyalla, Australia
Dioxin contaminated waste coming from the facility is dumped into a tailings dam in Spencer Gulf.
POPs-F

Dandenong, Australia
The Dandenong South Treatment Complex discharged a range of wastes into Dandenong Creek.
POPs-F

Bell Bay, Australia
A manganese sintering plant is the major source of PCDD/F pollution at the site.
POPs-F

McMurdo Station, Winter Quarters Bay, Antarctica
Even in what should be the pristine environment of Antarctica the McMurdo landfill has caused local contamination with a wide variety of inorganic and organic contaminants – including PCBs.
PCB

Source categories of waste contamination by POPs:

- Pesticides production/storage
- Waste incineration
- Landfilling/dumping/ open burning of wastes
- Chemical industry
- Metallurgical industry

Data about POPs levels in different environment compartments:

- Soil/sediment
- Waste residue
- Food (milk, eggs)
- Wildlife (fish)
- Human tissues (breast milk, blood)
- Air
- Water

POPs:

- PCDD/F – Polychlorinated dibenzo-p-dioxins and dibenzofurans (dioxins)
- PCB – Polychlorinated Biphenyls
- HCB – Hexachlorobenzene
- DDT – Dichlordiphenyltrichlorethan (pesticide)
- OCPs – Other Organochlorine Pesticides

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Gall Stereographic Projection

AL. ALBANIA
AN. ANDORRA
BEL. BELGIUM
B.H. BOSNIA AND HERZEGOVINA
KO. KOSOVO
L. LIECHTENSTEIN
LUX. LUXEMBOURG
MA. MACEDONIA
MN. MONTENEGRO
MO. MONACO
MOL. MOLDOVA
NETH. NETHERLANDS
SLO. SLOVENIA
S.M. SAN MARINO
SW. SWITZERLAND
U.A.E. UNITED ARAB EMIRATES
V.C. VATICAN CITY

Eloor, Kerala, India – HIL – the burnt down endosulfan plant. Photo by Nityanand Jayaraman, 2004.

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This is not a definitive map of world POPs "Hot Spots". Instead it presents a range of examples from every continent where POPs in solid wastes present risks to human health and the environment. There are many other sites which are not included here – either because of lack of space, absence of data or, in some cases, because the contamination has not yet been reported. If Governments are to "Keep the Promise" of the Stockholm Convention then these other sites also need to be investigated, reported and either remediated or, where pollution is ongoing, alternative processes which do not produce POPs waste should be used.

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World map of POPs waste hot spots

POPs – persistent organic pollutants – are hazardous chemicals which have distinctive and very dangerous properties. POPs persist in the environment for a long time; they can travel long distances through the air or sea; and they are 'bioaccumulative'. This means that they build up in living organisms, mainly in fatty tissue, and their concentration increases as they rise through each level of a food chain – and so the highest concentrations are normally found in the top predators like humans and polar-bears. POPs are highly toxic and levels found in some people and animals are above those known to cause health and biological effects. Many of these chemicals are 'endocrine disruptors' and act like hormones in our bodies; some of them are carcinogenic; the others are mutagenic and affect DNA or are teratogenic and can cause birth defects.

Some of the POPs are pesticides; other are industrial chemicals; and some occur as unintentional by-products of chemical and combustion processes. In all cases they stay in the environment for a very long time after the original sources of pollution are closed or stopped because the POPs degrade very slowly. Because of this, and the inevitability of their release into the environment when used in manufacturing or as products such as pesticides it is impossible to use or produce POPs without severe risks to human health and the environment. It is therefore essential to ban, or at the very least to severely restrict, their use and to eliminate historic residues and stockpiles.

Area of abandoned underground coal mines by Lampertice in the Czech Republic used for disposal of all kinds of wastes. Photo by Tomas Fertek, 2006.

Safer alternatives are invariably available and dramatically reduce the risks to people and wildlife. There are also much safer alternatives to those processes and practices, such as chlorine bleaching of paper or waste incineration, which generate POPs as unintentional by-products.

The Stockholm Convention

The Stockholm Convention is a global legally binding treaty which came into force on 17th May 2004 and, as of 1st January 2009, has 162 Parties. The Convention aims to eliminate 12 of the most significant POPs including nine pesticides; two industrial chemicals and polychlorinated dibenzodioxins and dibenzofurans (or, more commonly 'dioxins').

The convention is unique in it's scope because it addresses all the routes by which hazardous POPs might enter the environment, contaminate food chains and thus threaten human health. Previous conventions relevant to POPs dealt with only atmospheric emissions (the Convention on Long Range Transboundary Air Pollution) or with waste and waste shipments (the Basel Convention).

This map is focused on route of environmental contamination by POPs through waste. This way becomes more and more important, but also with very little monitoring and poor regulations in comparison with air pollution for example.

POPs in the Environment:

POPs escape into the environment in many ways. Some POPs were produced specifically for direct use in products, industrial equipment or as pesticides while other occur as by-products of industrial activities or as metabolites from the break-down of other chemicals released to the environment. Pathways into the environment can be direct or arise from spillage, discharges, venting, evaporation, waste products and so on.

Surrounding of the Dzerzhinsk, most polluted city in Russian Federation. Hazardous waste dumpsite. Photo by Eco-SPES, 2004.

Whilst the majority of environmental releases for many POPs are via waste disposal much less attention has generally been paid to this than to emissions to atmosphere or water. Many of the National Implementation Plans that are required to be prepared by parties to the Stockholm Convention reviewing releases in countries have concentrated almost exclusively on emissions to air, for example. This approach is difficult to understand when it is considered that of the total emissions of approximately 20 kg I-TEQ/y dioxins in the E.U. only 20% was emitted to air and around 80% discharged in the form of solid process residues and wastes.

Article 6 of the Stockholm Convention outlines the measures required to reduce or eliminate releases from stockpiles and wastes. This includes the need to define a "low" POPs content. This is necessary to distinguish between those POPs which must be *"destroyed or irreversible transformed so that they do not exhibit the characteristics of persistent organic pollutants "* and wastes which may be *"otherwise disposed of in an environmentally sound manner"*. This is a crucial distinction because even disposal in an "environmentally sound manner" can leave a damaging legacy of POPs with high levels of releases into the environment – particularly in those countries which lack an effective regulatory control system and which have limited analytical capacity to monitor and test waste treatments. The provisionally defined "low" POPs level is set in the Basel POPs Waste Guidelines but, unfortunately, at levels that are inappropriately high:

Table 2

POPs group	Low POPs Content Values
PCDD/PCDF	15 ppb (µg/kg)
PCBs, HCB, DDT and other POPs	50 ppm (mg/kg)

These limits are not protective of human health or the environment. If they are not significantly reduced then they threaten to fundamentally undermine the ultimate goal of the Stockholm Convention which is *"to eliminate POPs"*.

The level established for dioxins (PCDD/Fs), for example, at 15 µg I-TEQ/kg can be seen to be too high when we consider a recent incident in the UK where waste incineration bottom and fly ash was spread on the allotments (communal gardens for producing food) and poultry was contaminated by high levels of dioxins. The ashes spread on the allotments contained levels of dioxins in the range upto 4.2 µg I-TEQ/kg – less than a third of the current provisional "low" POPs level yet this resulted in eggs contaminated with up to 56 pg WHO-TEQ/g on lipid basis. Those eggs exceeded the 3 pg WHO-TEQ/g EU limit set for dioxin content in eggs by nearly 20 times! Indeed the EU limit was exceeded by almost all eggs sampled from the allotments measured after this incident .

If we continue to use these very high provisional "low POPs content" levels approved by both the Basel Convention and the Stockholm Convention we can certainly expect problems in many countries. The Abidjan scandal should provide a timely warning that the Basel Convention has not managed to effectively control international waste shipments and that we are a long way from eliminating the terrible damage that can be caused by the global trade in waste. With the current thresholds large quantities of POPs in waste could lawfully, and in compliance with both Conventions, be exported to developing countries under the label of, for example, *"construction material"* – as they were in Newcastle, England. Waste below "low POPs content" is not considered to be hazardous waste unless it has other hazardous properties in addition to any POPs.

If the definition of low POPs content levels stands, it will also become difficult for Parties to raise the money and to obtain the resources necessary to properly detoxify POPs wastes. In the large number of countries where open and largely unregulated dumping of waste is still prevalent then it is inevitable that damage will be caused to health and the environment if POPs are not eliminated.

POPs in waste lead to POPs in food

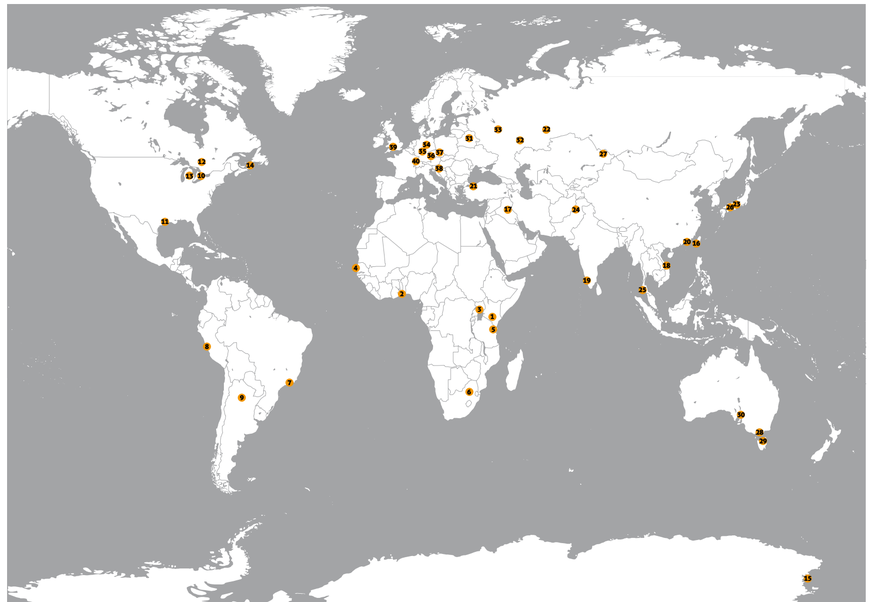
The different pathways leading to POPs (Persistent Organic Pollutants) content in waste can include:

- obsolete pesticides that include POPs like DDT, hexachlorobenzene, lindane and others which have became waste
- transformers, capacitors and other equipment with oils including polychlorinated biphenyls and/or terphenyls
- waste from destroyed buildings that were contaminated by POPs (chemical plant in which POPs were produced or which could originate as unintentionally produced chemicals, pesticides storage, storage for waste which contained POPs etc.)
- residues from processes where POPs such as dioxins (PCDD/Fs), PCBs and/or HCB are unintentionally produced (typical categories include waste incineration residues, sewage sludge from chlorine chemical plants etc.)
- contaminated soils and sediments and many, many others.

A few examples of POPs levels in different wastes and/or contaminated soils and their comparison with levels of food contamination related to these levels are listed in Table 3. This is further clear evidence that much lower levels of POPs in soils/wastes than those set as the provisional "low" POPs content limits has led to the serious contamination of food.

Table 1: International Standards for dioxin levels

ATSDR Interim Policy Guidelines		
≤ 50 ppt	Screening level	ATSDR, 1997, 2006
≥ 50 ppt ≤ 1,000 ppt	Evaluation level – proposed ≥ 50 ppt in draft update	ATSDR, 1997, 2006
≥ 1,000 ppt	Action level – proposed for deletion in draft update	ATSDR, 1997, 2006
Canadian Environmental Quality Guidelines		
4 ppt	Alert level	CCME, 2005a
New Zealand Interim Acceptance Criteria		
10 ppt	Agricultural	MoE, 1997
1,500 ppt	Residential	MoE, 1997
18,000 ppt	Industrial	MoE, 1997
90,000 ppt	Industrial – Paved, with Management Plan	MoE, 1997
21 ppt	Maintenance	MoE, 1997
EU Waste Incineration Directive		
0.3 ppt	release to water from waste incinerators	EU, 2000
Germany Federal and Lander Ministers of the Environment recommendations		
5-40 ppt	Agriculture	EU, 1999
100 ppt	Playgrounds	EU, 1999
1,000 ppt	Residential areas	EU, 1999
10,000 ppt	Industrial areas	EU, 1999
The Netherlands Guidelines		
1,000 ppt	Residential and agricultural areas	EU, 1999
10 ppt	Dairy farming	EU, 1999
10 pppt	Land with sensitive use	EU, 1999
250 ppt	Land with less sensitive use and groundwater extraction	EU, 1999
250 ppt	Land with less sensitive use	EU, 1999
Finland Ministry of the Environment, Department for Environmental Protection		
2 ppt	Proposed guideline	EU, 1999
500 ppt	Proposed limit value (agricultural and residential) for contaminated soil	EU, 1999
Hawaii Proposed dioxin action levels for East Kapolei Brownfield Site		
<42 ppt	Low risk, no further action required	DHH, 2006
>42 <390 ppt	Intermediate risk, further action	DHH, 2006
>390 ppt	High risk, Residential use not recommended in absence of remedial actions to reduce potential exposure.	DHH, 2006
US EPA Region 5 ecological screening levels		
11 ppt	PCDD soil guideline level	USEPA, 2003
38.6 ppt	PCDF soil guideline level	USEPA, 2003
US EPA Region 6 screening level for 2,3,7,8-TCDD		
39 ppt	Residential soil	USEPA, 2001
US EPA Region 9 preliminary remediation goal for 2,3,7,8-TCDD		
39 ppt	Residential soil	USEPA, 2000
Japan		
3ppb	Limit for solid wastes to landfill	Japan, 1971
10 pg-TEQ/l	Leaching limit	
Czech Republic		
1 ppt	Background	BIPRO, 2006
100 ppt	Pollution limit	BIPRO, 2006
500 ppt	Action limit – living area	BIPRO, 2006
1 ppb	Action limit – recreational	BIPRO, 2006
10 ppb	Action limit – industrial	BIPRO, 2006
Denmark		
<5 ppt	Target concentration soil used for agricultural purposes	BIPRO, 2006
5 – 40 ppt	Control of products for dioxin transfer	BIPRO, 2006
>40 ppt	Restrictions on crops with minimum dioxin transfer	BIPRO, 2006
> 100 ppt	Soil exchange on children's playgrounds	BIPRO, 2006
> 1 ppb	Soil exchange in residential areas	BIPRO, 2006
> 10 ppb	Soil exchange independent of the location	BIPRO, 2006



Dumpsite near Charsadda road on the edge of Peshawar, Pakistan. Photo by Sustianable Development Policy Institute (SDPI), 2005.

Risk reduction: How to Eliminate POPs in waste?

The question of how to eliminate POPs in wastes follows naturally after listing the problems above. The best way, of course, is prevention. This can be achieved by banning the production and use of intentionally produced POPs and by choosing technologies which do not create POPs such as dioxins or PCBs unintentionally. A good example is the problem of the treatment and disposal of medical waste in many developing countries. Incineration can be avoided by the use of good segregation practices in hospitals and treatment centres followed by non-combustion technologies such as autoclaves for any remaining waste. Alternative approaches can also be used for other kinds of waste to avoid incineration and co-incineration.

There are many different ways of treating POPs in existing waste. The expert group working on the BAT/BEP Guidelines reviewed the efficiency of non-combustion technologies in terms of destruction of waste containing POPs. Several of technologies considered promise effective destruction of POPs waste whilst at the same time preventing creation of new POPs as required by the Stockholm Convention.

Incineration of such waste, by contrast, whether in incinerators or in cement kilns results in the production of new POPs including dioxins. These new POPs then accumulate in wastes produced by these technologies (see the chart on picture 1) and are subsequently likely to be released into the environment.

Table 3

Substance	place (country)	level in soil/waste	low POPs limit	level in chicken eggs	limit for chicken eggs
DDT	Klatovy-Luby (Czech Republic)	35.6 ppm	50 ppm	2321 ppb	500 ppb
PCBs (7 markers)	Maincy (France)	0.024 ppm	50 ppm	0.299 ppm	0.2 ppm
PCBs (in TEQ)	Maincy (France)	0.001 ppb	no limit	24.98 ppt	6 ppt*
PCDD/Fs	Newcastle, St. Anthony's (UK)	0.02 ppb	15 ppb	27 ppt	3 ppt
PCDD/Fs	Newcastle, Hulne Terrace (UK)	0.910 ppb	15 ppb	31 ppt	3 ppt
PCDD/Fs	Maincy (France)	0.011 ppb	15 ppb	121.6 ppt	3 ppt
PCDD/Fs	Maincy (France)	0.037 ppb	15 ppb	25.75 ppt	3 ppt
PCDD/Fs	Libis (Czech Republic)	0.026 ppb	15 ppb	23 ppt	3 ppt
PCDD/Fs	near aluminium plant (Switzerland)	0.013 ppb	15 ppb	12 - 19 ppt	3 ppt
PCDD/Fs	Rheinfelden (Germany)	0.377 - 2.168 ppb	15 ppb	12.7 - 514 ppt	3 ppt

* Σ PCDD/Fs & DL PCBs

Mbeubeuss – large dumpsite in Dakar's neighbourhood. Photo by PAN Africa, 2005.

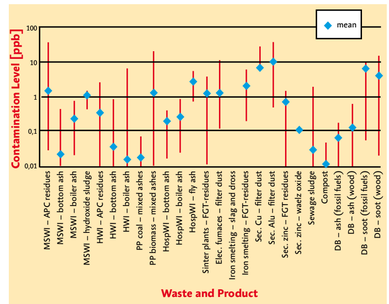
Hot spots

◆ Contamination source 🚗 Characteristic 🐟 POPs

AFRICA **1 Kitengela/Athi River, Kenya** ◆ waste incineration 🚗 This hazardous waste incinerator which handles agro-chemicals, medical wastes and hazardous industrial chemicals is located in a residential area. Residues from the incinerator are tipped close to the site without any containment with a high risk of environmental contamination. Levels of POPs were measured in the ambient air during the African POPs monitoring project but, like similar wastes in Africa there is no publically available data on the levels in the residues. 🐟 PCDD/Fs, PCBs, HCB **2 Lome, Togo** ◆ waste incineration 🚗 Waste incinerator is located close to some farms. Fly ash and bottom ash are visible on the ground and could contaminate crops. No concentration data are available – which is typical for these areas but levels are likely to be medium – high. 🐟 PCDD/Fs **3 Luwero and Nakasongola, Uganda** ◆ waste incineration 🚗 Waste incinerator burns different types of wastes. Incineration ash residues are buried in a pit within the barracks area in Nakasongola. 🐟 PCDD/Fs **4 Mbeubeuss, Senegal** ◆ dumping, chemical industry, metallurgical industry 🚗 Large dumpsite in Dakar's neighbourhood; most likely pentachlorophenol waste is stored there and any other chemical waste contaminated with dioxins. High levels of POPs have been measured in local eggs. 🐟 PCDD/Fs, PCBs, HCB **5 Old Korogwe, Tanzania** ◆ pesticides storage 🚗 After removing stocks of DDT, highly DDT contaminated soil remains around the site. Level of ΣDDT in soil sampled by Agenda in March 2009 was over 804 mg/g. 🐟 DDT **6 Vanderbijlpark, South Africa** ◆ metallurgical industry 🚗 Large dumpsite of residues from iron and steel manufacturing plant; waste from the plant is likely to be contaminated by POPs, but no measurements available for the residues, data only on air in the surrounding of facility. ◆ PCBs, HCB, potentially also PCDD/Fs **LATIN AMERICA** **7 Cidade dos Meninos, Brazil** ◆ pesticides production 🚗 After the Lindane factory closed piles of residues were left behind causing the contamination of the ground and soil. 🐟 DDE, DDD, DDT, HCH **8 El Zapallal, Peru** ◆ open burning of wastes, metallurgical industry, waste incineration 🚗 There is a landfill site in which waste with high levels of contamination including ash from incinerators and illegal smelting activities have been dumped. 🐟 PCDD/Fs **9 Santiago del Estero, Argentina** ◆ dumping, pesticides storage 🚗 This is a dump containing banned/obsolete pesticides and related wastes where it has not been possible to identify the responsible companies. The dump has no enclosure and is only 150 m from a school in one of the poorest provinces of Argentina. UNEP comment *"official numbers grossly underestimate the real situation due to illegal or non-reported contaminated sites throughout the Region"*. This is typical of many countries around the world. 🐟 HCB, DDT, DDE, DDD, HCH (alpha, beta, gamma and delta), Aldrin, Heptachlor, Dieldrin, Chlordane (alpha and gamma) **NORTH AMERICA** **10 Hamilton, Canada, Ontario** ◆ chemical industry 🚗 In July 1997, at least 400 tonnes of PVC were burned in a fire at Plastimet, Inc. The whole incident was estimated to have released 15 g TEQ dioxin to the environment in smoke alone and left heavily contaminated residues. 🐟 PCDD/Fs **11 Lake Charles / Calcasieu Estuary, USA, Louisiana** ◆ chemical industry, dumping 🚗 The dumping of "heavy ends" (tars) from the production of chlorinated solvents and vinyl chloride (VCM) by PPG Industries, Inc.; Condea-Vista; Conoco between 1962 and 1976. PPG dumped at least 120,000 tons of dioxin-contaminated wastes (heavy ends) into the bayou at edge of the company's property. 🐟 PCDD/Fs, PCBs, HCB **12 Rouyn-Noranda, Canada, Quebec** ◆ metallurgical industry 🚗 Electrolysis of molten magnesium chloride ($MgCl_2$) using graphite (carbon) electrodes; and purification of molten $MgCl_2$ ("chloridation") using graphite mixing blades. The chemical reaction between the chlorine and carbon in the process resulted in a cocktail of organochlorine POPs including 479 to 539 g TEQ of dioxin and 1,552 to 1,684 kg for disposal off-site. The factory is now closed. 🐟 PCDD/Fs, HCB **13 Saginaw and Tittabawassee River, USA, Michigan** ◆ chemical industry, waste incineration 🚗 The contamination is extensive throughout the floodplain downstream from Dow Chemical's global headquarter in Midland, Michigan. The very high levels of dioxin in Midland soils and dumps were caused mainly by historical discharges and from incinerators operated by the Dow Chemical Company. A level of more than 1.6 million parts per trillion (ppt) of dioxin was reported in one sample of sediment taken from the Saginaw River. 🐟 PCDD/Fs **14 Sydney, Canada, Nova Scotia** ◆ metallurgical industry 🚗 The Sydney Tar Ponds contain approximately 700,000 tonnes of sediments contaminated with polyaromatic hydrocarbons (PAH), including an estimated 50,000 tonnes of material containing PCBs in concentrations over 50 parts per million (ppm). The site was contaminated by wastes from old coke ovens. 🐟 PCBs **ANTARCTICA** **15 McMurdo Station, Winter Quarters Bay, Antarctica** ◆ landfilling 🚗 The Winter Quarters Bay landfill was used between 1956 and 1980 for depositing waste and debris from McMurdo Station. The landfill has leaked a wide variety of organic and inorganic contaminants, including fuel-related volatile organic compounds (VOCs), semi-volatile organic compounds, tetrachloroethene, petroleum hydrocarbons (including diesel, heavy oil, and kerosene), PCBs, and metals including elevated concentrations of Cd, Cr, Pb and Zn. 🐟 PCBs **ASIA** **16 Anshun, Taiwan** ◆ chemical industry 🚗 The factory operated a chlor-alkali process (1942–1977) and produced pentachlorophenol "PCP" (1964–1979) but is no longer operating. Historic contamination has migrated into neighbouring fishponds – local soil and fish samples are both highly contaminated with dioxins. 🐟 PCDD/Fs **17 Balad, Iraq** ◆ open burning of waste 🚗 This large open burn pit is typical of many in Iraq and Afghanistan where military wastes are burned in the open. The wastes include plastics, electronics and hazardous materials and will generate large quantities of dioxins in the air and ashes. A leaked memo by the US Department of Defense described it as "an acute health hazard." The Chief of Air Force Aeromedical Services confirmed that the pit's emissions of "known carcinogens" posed a "chronic and acute health hazard to our troops and the local population." 🐟 PCDD/Fs and possibly PCBs, HCB **18 Da Nang, Bien Hoa, and Phu Cat, Vietnam** ◆ chemical industry 🚗 Contamination is due to the spillage of the defoliant 'Agent Orange'. The Vietnamese Ministry of National Defence found an average dioxin level of about 35,000 ppt TEQ at former US airbases Da Nang, Bien Hoa, and Phu Cat. 🐟 PCDD/Fs **19 Eloor, India, Kerala** ◆ pesticides production 🚗 The plant produces DDT, Dicofol and Endosulfan and also hydrochloric acid/sulphuric acid as by products. It has caused permanent contamination and emits pollutants. 🐟 DDT and its metabolites, endosulfan, isomers of HCH, PCDD/Fs **20 Guiyu, China** ◆ open burning of electronic waste 🚗 Active electronic waste recycling area with perhaps the highest levels of dioxins amongst all hotspots. 🐟 PCDD/Fs **21 Izmit, Turkey** ◆ waste incineration, landfilling 🚗 The sludge and ashes resulting from the waste incineration facility are being disposed to a dump which is constructed near the incineration plant as an integrated disposal facility located at Izmit. 🐟 PCDD/Fs, PCBs, HCB **22 Karabash and Tobolsk, Russia** ◆ metallurgical industry 🚗 This included a former copper smelting facility. Elevated levels of dioxin have been found in breast milk locally. 🐟 PCDD/Fs, PCBs **23 Nose Town, Japan, Osaka Prefecture** ◆ waste incineration 🚗 Approximately 11,000 tons of dioxin contaminated soil had been left near the municipal waste incinerator in Nose Town, Osaka. Cooling water from the facility contaminated soil in Nose Town Area. Dioxin levels at contaminated waste storage facility in Toyonogun Bika Center as well as in the surrounding area exceed central governmental limits. Remedial work on the contaminated soils is underway. 🐟 PCDD/Fs **24 Peshawar, Pakistan** ◆ waste incineration, dumping 🚗 Ashes from the incineration of medical waste are dumped around the site and in wells in spite of high levels of dioxin. This is the general practice with residues from medical waste incineration in Pakistan. 🐟 PCDD/Fs, PCBs **25 Phuket, Thailand** ◆ waste incineration, landfilling 🚗 The Phuket landfill/incinerator complex comprises of separate facilities for the incineration of municipal and medical wastes. Bottom ash/clinker and fly ash from these operations has been dumped or stored in ash pits constructed within the boundaries of the complex. The storage area containing bottom ash residues was partly filled with water, giving it the appearance of a waste lagoon. Local mangrove swamps are also used for dumping these wastes. ◆ PCDD/Fs, PCBs **26 Teshima Island, Japan** ◆ dumping 🚗 Industrial waste was illegally dumped into a gravel pit site of 30 ha in Teshima Island. 500 thousand tons of waste including residues from cars; home electric appliances; slags; incineration residues; and waste oil were dumped from late 1970s – 1988. Remediation started in 2003 and should take 10 years. ◆ PCBs **27 Ust-Kamenogorsk, Kazakhstan** ◆ chemical industry, dumping 🚗 The waste pond of the Ust-Kamenogorsk capacitors plant is located on mountain slopes. There is a real threat of infiltration of PCBs to the Irtysh River via groundwater. Analysis of samples of soil at the beach and water from the pond revealed that PCBs levels reach 12,438 mg/kg in soil and 0.19 mg/kg in water. 🐟 PCBs **AUSTRALIA** **28 Dandenong, Australia** ◆ landfilling / dumping 🚗 Prior to 1995, the Dandenong South Treatment Complex accepted a range of waste streams such as trade waste taken waste from industrial sites and domestic waste which were treated via biofiltration and land filtration prior to discharge to Dandenong Creek. 🐟 PCDD/Fs **29 Bell Bay, Australia** ◆ metallurgical industry 🚗 Tasmanian Electro Metallurgical Co Pty Ltd (TEMCO) – a manganese sintering plant is the main source of PCDD/Fs pollution at the site. In addition to air emissions, solid waste may be a significant dioxin pathway. Dioxin levels in soil and fish surrounding the plant, while not very high, are well above background levels recorded in Victoria and New Zealand, demonstrating that dioxin is building up in the surrounding environment. 🐟 PCDD/Fs **30 Whyalla, Australia** ◆ metallurgical industry 🚗 Dioxin contaminated waste coming from the facility is dumped into a tailings dam in Spencer Gulf. 🐟 PCDD/Fs **EUROPE** **31 Belarus/i, Belarus** ◆ waste incineration (most likely source) 🚗 Partly destroyed storage buildings near a village 30 km from Minsk where the toxic construction material is stored in semi-open air conditions. The contamination is most likely come from waste incineration residues imported from Germany 🐟 PCDD/Fs **32 Chapaevsk, Russia** ◆ chemical industry 🚗 Chapaevsk is one of the most polluted town in Russia. The area is contaminated with dioxins and metals, including lead, mercury and arsenic. 🐟 PCDD/Fs **33 Dzerzhinsk, Russia** ◆ chemical industry, waste incineration, landfilling 🚗 This is the most polluted industrial town in the world, a place with high levels of POPs contamination from a variety of different sources. 🐟 PCDD/Fs, PCBs, DDT **34 German salt mines, Germany** ◆ chemical industry, waste incineration, metallurgical industry 🚗 In Germany, there are more than 20 mines allowed to receive waste for long-term underground storage. Approximately two thirds of these mines are located in salt rock geologies and these are the only mines permitted to handle POPs wastes. They include, for example Herfa Neurode (Hesse), since 1972; Zielitz (Saxony-Anhalt), since 1994; Heilbronn (Baden-Württemberg), since 1987 Bernburg (Saxony-Anhalt), since 1992. Whilst salt mines are perceived by the authorities as safe 'final storage' there have been several leaks and a particularly high profile scandal over the past years has been caused by the leakage of radioactive waste from the Asse II mine. This casts serious doubts over the claims swamps are also used for dumping these wastes. ◆ PCDD/Fs, PCBs **35 Giessen, Germany** ◆ metallurgical industry 🚗 "Kieselrot" is the common name for the red siliceous slag residue from the Marsberg copper ore smelting process. It was used to a considerable extent in the 1950's and 1960's as a covering material for sport grounds and playgrounds, and also in road and path construction. Because of its dioxin contamination, many places were closed and rebuilt during last few years. The sports ground in Giessen is currently undergoing remediation. 🐟 PCDD/Fs **36 Klatovy-Luby, Czech Republic** ◆ pesticides storage 🚗 This former pesticides storage site remains highly contaminated by lindane, DDT, triazine and other pesticides even more than 20 years after this use was stopped. Maximum levels of ΣDDT measured in 2008 were up to 5,381 mg/kg in debris/plaster! and 70 mg/kg in soil. There are approximately 80 such "small" contaminated sites within the Czech Republic. 🐟 DDT, HCB, OCP, PCBs **37 Lampertice, Czech Republic** ◆ chemical industry, waste incineration, landfilling 🚗 Site of an abandoned underground coalmine was used for preparation of mixture of wastes including waste incineration residues and metallurgy residues (including fly ash) as well as sewage sludge from chemical plants and the chlorine industry. This was a notable source of HCB problems. 🐟 PCDD/Fs, HCB, PCBs dioxin pathway. Dioxin levels in soil and fish **38 Puto, Croatia** ◆ waste incineration, open burning of wastes (accident) 🚗 There are still 250 tons of ash lying around the incinerator site of former hazardous waste incinerator. While no POPs testing results have been made public the levels are likely be significant and heavy metal contamination exceeds limit values. ◆ PCBs, PCDD/Fs **39 Wingmoor Farm, UK** ◆ waste incineration 🚗 Monofill hazardous waste landfil lined with clay, incinerator air pollution control ashes are 'treated' on site by mixing with leachate or contaminated water and disposed of to open cells. Off-site exposure may be occurring through APC (air pollution control) residues blowing off site where they can be inhaled or contaminate food and soil. 🐟 PCDD/Fs **40 Wittelsheim, France** ◆ landfilling, waste incineration, metallurgical industry 🚗 Potash-salt mine in Wittelsheim was opened in February 1999 as the first underground landfill in France. The licensed capacity of the mine was 320,000 tons (for 30 years). Wastes deposited included galvanising sludge, spent catalysts and residues from waste incineration. In September 2002 an underground fire broke out and as a consequence of this the landfill and the adjacent mine were closed. 🐟 PCDD/Fs, PCBs, HCB

Waste incinerator in Phuket, Thailand. Photo by Campaign for Alternative Industry Network (CAIN), 2007.

Pic. 1: Distribution of Dioxin Contamination in Wastes



Abbreviations used in the text and the tables:

DDT	Dichlorodiphenyltrichloroethane (pesticide, POP)
DDD/DDE	Metabolites of DDT
DL PCBs	Dioxin-like PCBs
HCB	Hexachlorobenzene (technical substance, pesticide, POP)
HCH	Hexachlorocyclohexane (pesticide) gamma-HCH – gamma isomer of hexachlorocyclohexane, usually called lindane (pesticide)
I-TEQ	International toxic equivalent
OCPs	Organochlorine pesticides
PBDEs	Polybrominated diphenylethers (brominated flame retardants)
PCBs	Polychlorinated biphenyls (technical substance, contaminant, POP)
PCDD/Fs	Polychlorinated dibenzo-p-dioxins and dibenzofurans, shortly called "Dioxin" (unintentionally produced POP)
WHO-TEQ	World Health Organisation toxic equivalent (WHO 1998)

Units

mg	milligram	10^{-3}g	ppm	mg/kg
µg	microgram	10^{-6}g	ppb	µg/kg
ng	nanogram	10^{-9}g	ppt	ng/kg
pg	picogram	10^{-12}g		
fg	femtogram	10^{-15}g		