Case study: PCDDs/PCDFs, PCBs and other organic contaminants in soil and ash samples from the scene of a fire at a hazardous waste dumpsite in Poland

DIOXIN 2019 Kyoto Japan

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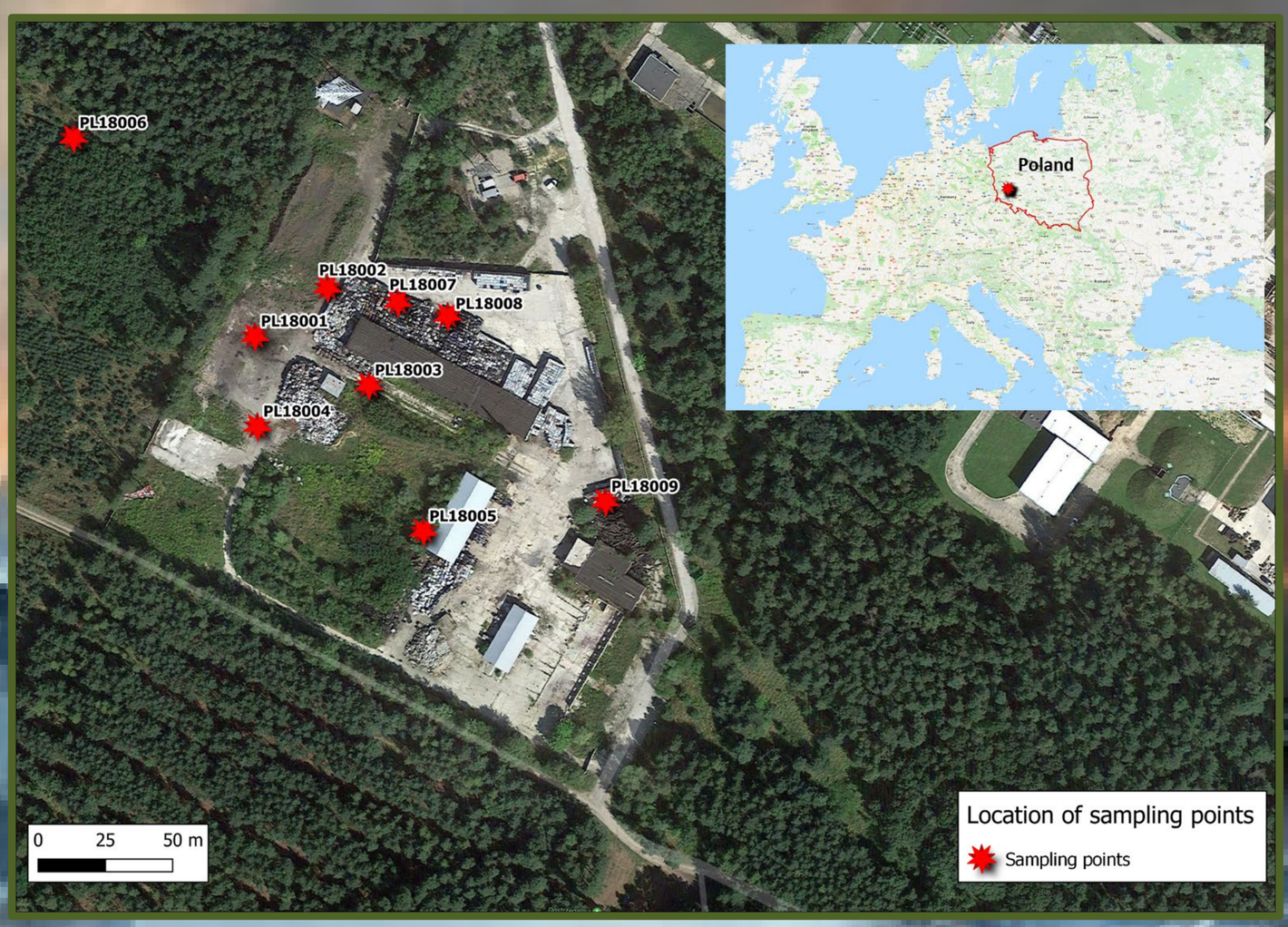

Introduction

A series of a large scale fires occurred at the hazardous waste dumpsite located in Jakubow, Radwanice, Poland, during July-August 2018. About two acres of land and forest surrounding the dumpsite were affected directly by the fire and by substances stored on the site. Polish environmental protection services confirmed that the dumpsite was being used to store a wide variety of wastes including paints and varnishes, printing toner, adhesives and sealants, sludges of printing inks, emulsions and solutions from metalworking, technical oils (engine, gear, and lubricating), packaging of hazardous substances, sorbents and plastics.

In September 2018, we investigated contaminants present in samples of soils, ashes and other solid materials within the areas of the site affected by fire, including analysis of a subset of the samples for PCDDs/PCDFs and PCBs.

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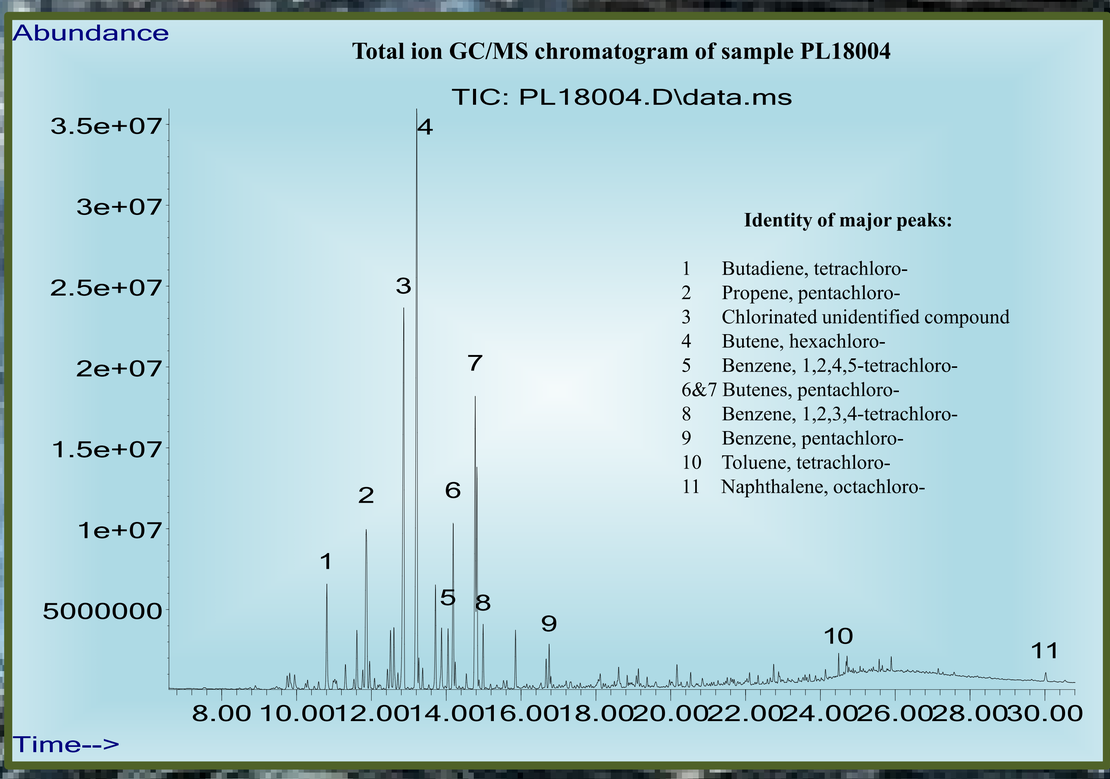
Materials and Methods

Nine samples of soil and ash were received for analysis at Greenpeace Research Laboratories. Semi-volatile organic compounds (sVOCs) were isolated from samples using Accelerated Solvent Extraction (ASE) (pentane:acetone, ratio 3:1). After separation of extracted compounds between organic (e.g., pentane) and aqueous phases, the latter was further extracted into methanol using Solid Phase Extraction (SPE) technique. Extracted compounds were subsequently identified as far as possible using gas chromatography/mass spectrometry (GC/MS) in SCAN mode and liquid chromatography-Orbitrap-mass spectrometry (LC-Orbitrap-MS). In addition, two of the samples were analysed for chlorinated dioxins/furans and PCBs by Marchwood Scientific Services, Southampton, UK.

Sample Code	PL18001	PL18002	PL18003	PL18004	PL18005	PL18006	PL18007	PL18008	PL18009
Sample type	soil	soil	soil	soil	soil	soil	ash	ash	ash
Number of sVOCs isolated	97	194	114	455	159	399	341	251	357
Number of sVOCs identified to >90%	39	67	39	125	62	120	104	89	108
Percentage of sVOCs identified to > 90% (%)	40	35	34	27	39	30	30	35	30
Chlorinated compounds	11	20	6	89	22	16	2	10	11
Nitrogen-containing chlorinated compounds	nd	2	nd	3	nd	1	1	nd	nd
Nitrogen-containing compounds	nd	4	1	1	nd	5	2	5	7
Phosphorus-containing chlorinated compounds	nd	3	nd	2	nd	3	3	2	nd
Phosphorus-containing compounds	nd	2	1	nd	2	2	nd	nd	nd
Phthalates, adipates & relative compounds	3	7	1	1	2	1	30	7	nd
Carboxylic/fatty acids and derivatives	1	6	2	9	8	15	17	15	8
Phenol and its derivatives	nd	6	nd	2	1	7	4	8	2
PAHs and their derivatives	nd	2	1	nd	4	1	1	nd	15
Alcohols & their derivatives	nd	1	1	2	1	9	5	3	nd
Aldehydes & ketones	nd	2	nd	2	3	7	6	3	2
Alkylated benzenes	7	2	4	nd	3	21	2	2	19
Linear & branched aliphatic hydrocarbons	15	7	19	8	13	18	24	27	31
Indane/Indene and derivatives	2	nd	2	nd	1	3	1	2	2
1,1'-Biphenyl and its derivatives	nd	1	nd	1	nd	4	1	1	9
Cholestane and derivatives	nd	1	nd	2	1	1	1	1	nd
Other compounds	nd	3	1	3	1	9	5	2	1

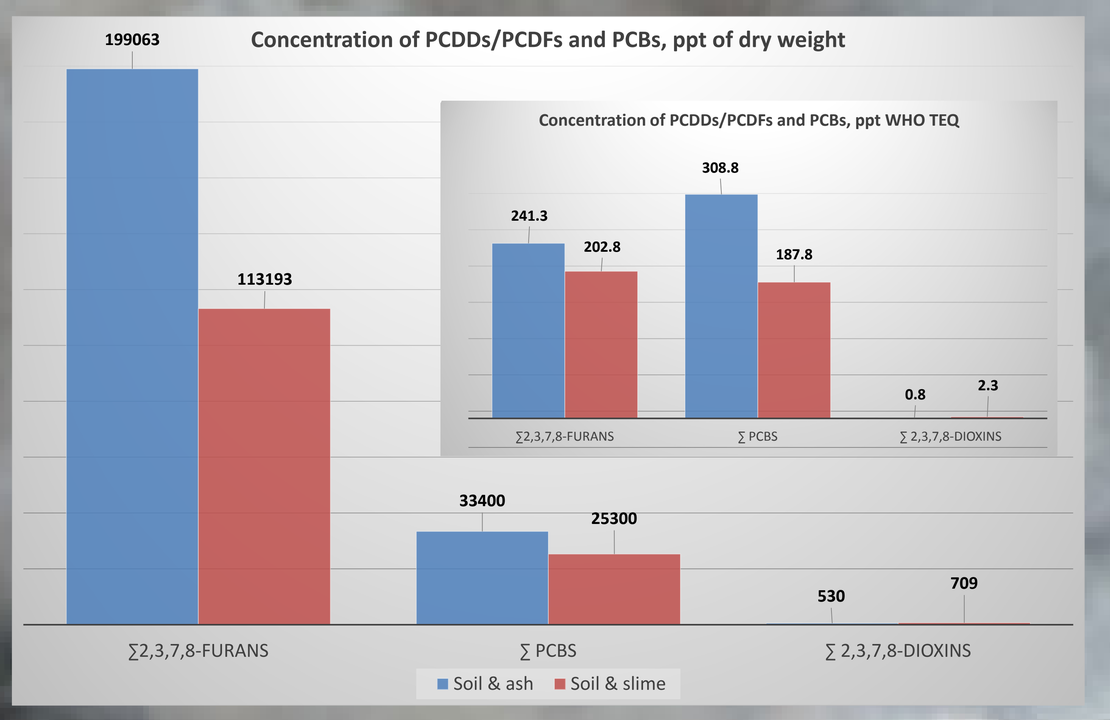


Results and Discussion

Organic compounds that could be reliably identified through GC/MS analysis were represented by a diverse range of toxic chemicals (see Table above), with chlorinated compounds being the most common (to a maximum of 89 individual chlorinated organic compounds in sample PL18004, see chromatogram above). It is important to note that organic chemicals detected in samples in this study could have arisen not only from the waste stocks localised at this dump site, but also as a result of thermal degradation and incomplete combustion of such wastes during the fires.

LC-MS targeted and non-targeted screening identified additional substances across the nine samples analysed, including polyfluorinated surfactants, 5 phthalate esters, benzotriazole and its derivatives, and 4 pesticides (Imidacloprid, Thiamethoxam, N,N-Dimethyl-N'-(4-methylphenyl)sulfamide, and DEET), among others. Full results of the study are available online.*

The two samples selected for additional analysis contained 550.88 and 392.90 ng kg^{-1} TEQ respectively of chlorinated dioxins, dibenzofurans and dioxin-like PCBs combined, with the TEQs dominated in both samples by the contribution from furans and PCBs (see graph on the right). This implies that there may be serious hotspots of contamination on the site. It is possible that this contamination may have arisen as a result of the incomplete combustion of the organochlorine chemicals present in the waste stockpile. Given the preponderance of dioxin-like PCBs and chlorinated dibenzofuran congeners, it is also possible that this dumpsite has at some stage been used to store or dispose of PCB technical mixtures. As has been known for many years, such mixtures can be contaminated with chlorinated dibenzofurans, as a result of their formation during manufacture or use of PCBs.



Conclusion

The current study has shown that soils and ashes collected in September 2018 from areas of a chemical dumpsite located in Jakubów, Radwanic, Poland, following several large-scale fires, are highly contaminated by a diverse range of toxic organic contaminants, including persistent organic pollutants, either as a result of the storage of such chemicals on site or their subsequent formation as products of incomplete combustion during the fires. This site must be subject with some urgency to more detailed investigations and analytical characterisation in order to determine the precise nature, extent and severity of chemical contamination in the soils and residues on site, as well as looking for the potential spread of contamination to the surrounding area. Steps must also be taken to contain hazardous residues until they can be properly dealt with, to compile thorough documentation on wastes stored at the site prior to the fire, and to review the suitability of such sites for storage or disposal of hazardous wastes.

* http://www.greenpeace.to/greenpeace/wp-content/uploads/2019/01/AR-2018-06.pdf