ACTIVE SAMPLING AND ANALYSIS OF DIOXINS AND POLYAROMATIC HYDROCARBONS BOUND TO FINE PARTICLES IN THE VICINITY OF A MUNICIPAL SOLID WASTE INCINERATOR

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Abstract
Exposure to fine particles can cause serious health problems including premature mortality and higher instances of respiratory illnesses. Particle pollution is made up from a number of components, including persistent organic pollutants (POPs), heavy metals, nitrates and sulphates. Within the group of compounds classified as POPs, dioxins can be emitted through waste incineration. Fine particles and the associated POPs are wind transported over long distances. For this reason, it is considered that air is the key medium to be sampled in global monitoring programmes. A new generation of active air samplers was used to measure selectively according to actual local wind conditions. By the use of a multi-stage impactor, cut points for the particulate fraction at aerodynamic diameter of 10 µm, 2.5 µm and 1 µm were obtained. In addition the distribution of Dioxins/Furans and Benzo(a)Pyrene (BaP) on the different sizes of particulate matter was investigated.

Introduction
Particle pollution includes “inhalable coarse particles”, with a diameter lager than 2.5 µm and smaller than 10 µm and “fine particles”, with diameter of 2.5 µm and smaller (PM 2.5 or particulate matter <2.5µm). Inhalable coarse particles can be found near roadways and dusty industries. Fine particles are mainly found in smoke and haze. Exposure to these particles can cause serious health problems including premature mortality and higher instances of respiratory illnesses.[1] Due to this in many countries limits for PM 10 (particulate matter < 10 µm in aerodynamic diameter) and/or PM 2,5 have been already established. Particle pollution is made up from a number of components, including persistent organic pollutants (POPs), heavy metals, nitrates and sulphates.[2] Within the group of compounds classified as POPs, dioxins can emitted through waste incineration. POPs are chemicals that remain intact in the environment for long periods, are geographically widely distributed, accumulate in the fatty tissue of living organisms and are toxic to humans and wildlife. Fine particles and the associated POPs are wind transported over long distances.[3,4] For this reason, it is considered that air is the key medium to be sampled in global monitoring programmes. For this purpose, a new generation of active air samplers was used. Wind directional ambient air samplers enable us to measure selectively according to actual local wind conditions. Used together with a multi-stage impactor, cut points for the particulate fraction at aerodynamic diameter of 10 µm, 2.5 µm and 1 µm can be obtained.[5,6]

Materials and methods
Directional air samplers were used on the basis of the MONARPOP project, which is the first example of assessment of contamination in the Alps regarding persistent organic substances.[7,8] As well as differentiating releases according to origin, directional air samplers also make it possible to perform distant emissions checks of industrial sites or plants that would otherwise be difficult to check directly and which, in any case, pose a potential threat of pollution to the environment. One or more directional air samplers are placed in proximity to a potential source of pollutants and collect pollutants on different cartridges according to wind direction. In this way, it is possible to distinguish the contribution of the “source” from that of the “baseline”.

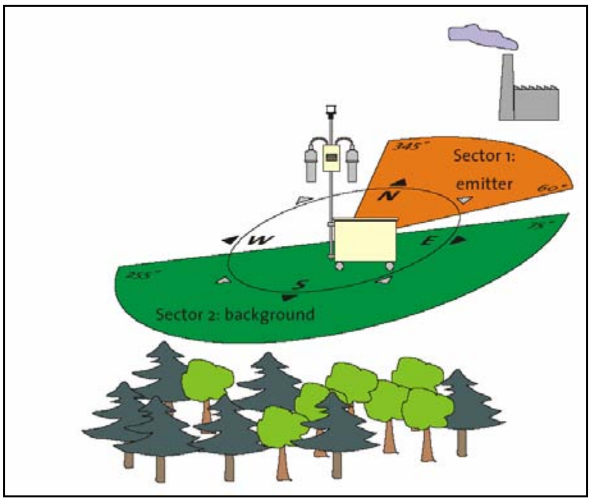

Figure 1: Air sampler placed in the vicinity of a potential pollutant emitter

In line with wind direction, samples can be taken on three different cartridges, two of which are active according to wind direction and the other in calm conditions. Impactors for fine particles that separate the PM 10, PM 2.5, and PM 1 fractions were added to each of the cartridges of the directional air sampler (Monitoring Systems, Kottingbrunn, Austria).
The meteorological characteristics linked to release processes concerning the Bolzano municipal waste incinerator have been examined. The prevailing wind line was identified along a south-north axis. The main deposit sites were thus identified to the south and north of the plant (see Fig. 1).

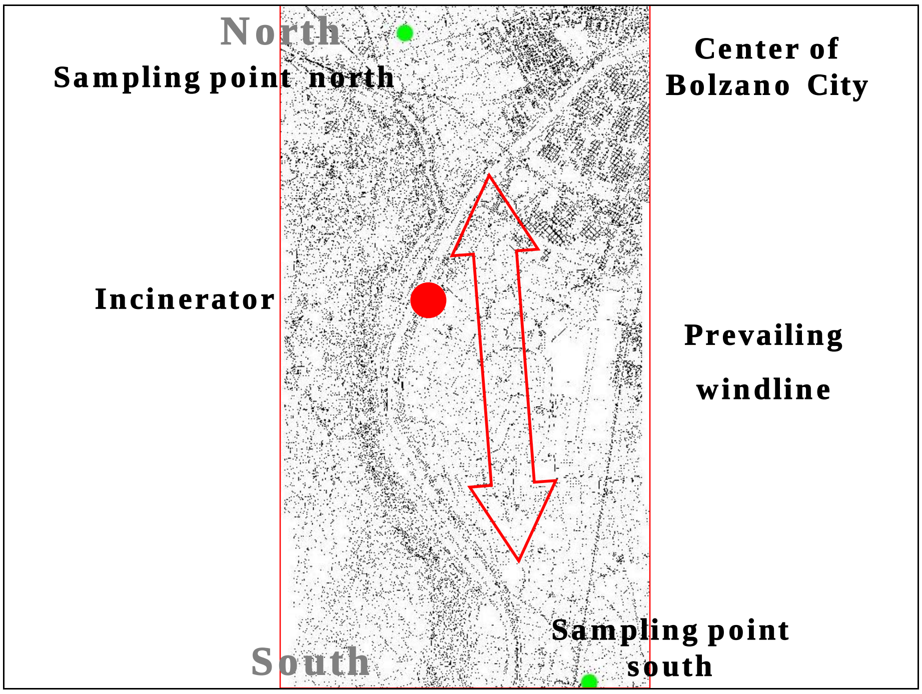

Figure 2: Prevailing wind line at the Bolzano municipal waste incinerator

Results and Discussion:

The first monitoring campaign, August-September 2006, used two directional air samplers placed to the north and south of the incinerator, each with two cartridges and collecting samples with the wind coming from the north and south respectively. At the end of the sampling the dioxin/furan concentration was determined.

Table 1: First sampling campaign: 29 August - 15 September 2006

	PCDD/F concentration in fg I-TEQ/m^3	
	Wind from north	Wind from south
Sampl. point: north	6	11
Sampl. point: south	20	15

The obtained measurement results listed in Table1 show generally low values of dioxins/furanes (PCDD/F) in air compared to other studies. Values of 10 to 20 fg I-TEQ/m^3 are usually found in summertime in domestic/rural area. When the wind is blowing from north a slightly increase in the dioxin concentration could be observed.

But analyzing the wind data we found on sampling site north a much higher frequency on north wind conditions, so the sampled volume was more than four time higher than on the south sampling site.

To get more information a second sampling campaign with three directional air samplers was performed. The third sampler was installed in the center of Bolzano City in an area not influenced by the incinerator, collecting on two sampling cartridges when the wind came from north or south respectively. The other two samplers still worked in the same place in north and south of the incineration plant. These samplers were able to work with three cartridges to collect the air also in case of calm wind conditions on the third cartridge . The parameters analysed were dioxins, PAH and, for the samplers north and south of the incinerator, also PM10, PM2.5 and PM1. The test standards used were EPA 1613 for dioxins, gravimetric assessment for PMs and gas chromatographic-isotope dilution coupled with high-resolution mass spectrometry for Benzo(a)pyrene.

Table 2: Second sampling campaign: 22 December 2006 - 18 January 2007

	PCDD/F concentration in fg I-TEQ/m^3		
	Wind from north	Wind from south	Calm wind conditions
Sampling point: north	90	79	89
Sampling point: south	59	52	84
Sampling point city	155	259	

Results from table 2 show that the influence of the incineration plant on the dioxin concentration in the air of Bolzano is simply not visible. The highest value was measured on the north sampling site when the wind blow from north. When this air is transported by wind to the south sampling site we measured a lower concentration. The same situation when the wind came from south. Under this conditions, the north sampling site showed under this conditions lower results. Relatively high concentrations where found in calm wind conditions. This is a clear evidence that the urbanisation with domestic heating and road traffic are the main sources of POPs in the air.

Additionally, the distribution of POPs on the different sizes of particulate matter was investigated. Dioxins/Furans (PCDD/F) and Benzo(a)pyrene (BaP) were analyzed in the different PM fraction.

Table 3: PCDD/F in the different PM fraction on the south sampling site

	PM 10		PM 2,5		PM 1	
		PCDD/F		PCDD/F		PCDD/F
	µg/m^3	fg I-TEQ/m^3	µg/m^3	fg I-TEQ/m^3	µg/m^3	fg I-TEQ/m^3
Wind from north	44	59	38	56	33	53
Wind from south	78	52	70	50	63	47
Calm wind cond.	45	84	39	82	34	77

Table 4: BaP in the different PM fraction on the south sampling site

	PM 10		PM 2,5		PM 1	
		BaP		BaP		BaP
	µg/m^3	ng/m^3	µg/m^3	ng/m^3	µg/m^3	ng/m^3
Wind from north	44	2,2	38	2,1	33	1,9
Wind from south	78	2,6	70	2,5	63	2,3
Calm wind cond.	45	3,1	39	3,0	34	2,8

Conclusion:
To measure the impact of a potential emission source up and downstream the prevailing windline together with wind selective sampling are useful tools. The small differences in the measurement results reported in Table 3 and 4 show that the waste incineration plant of Bolzano is not a notable source of dioxins, PAH's, and fine particles. The contribution of diffuse sources like domestic heating and road traffic are the main sources. Regarding the distribution of organic pollutants we could find an approximately 90 % in the PM 1 fraction. This fraction presents in our study only 70 % of the PM 10 fraction. PM 1 has a higher specific surface where organic pollutants can easily be bound on the surface.

References:

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