PCDD/F LEVELS IN AMBIENT AIR IN THE PROXIMITY OF A MUNICIPAL SOLID WASTE INCINERATOR

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INTRODUCTION

- In the present study a *municipal solid waste incinerator* (*MSWI*) emission and ambient air samples in *four surrounding locations* (Zone A, B, C and D) were simultaneously collected.
- The *MSWI* investigated is located in an highly industrialized area and it consisted of three independent incinerating units, each with its own heat recovery system. It is equipped with semidry lime sorbent and activated carbon injection system and fabric filters (FF).
- Prior to stack release to the atmosphere the gas is treated with scrubber liquid blow downs. PCDD/Fs were measured and expressed as TEQ concentrations according to the international (I-TEF) and World Health Organization toxicity equivalent factors (WHO-TEQ) schemes were calculated. In recent years the levels of PCDD/Fs emitted by *MSWI* have been frequently used to detect and quantify the atmospheric concentrations of these pollutants in zones near to *MSWI* and used as indicators of the quality of the air.
- One of the aims of were to assess the impact of the *MSWI* emissions on PCDD/F air levels and to distinguish the contribution of the *MSWI* from other local emission sources of the area. Principal component analysis (PCA) was used to compare the "fingerprint" of the PCDD/F homologue profiles of samples analyzed and samples related to known sources of emission. PCA is a very powerful multivariate data analysis technique for finding similarities between samples with by a large number of variables, and it has been frequently used to identify the origin of PCDD/F contamination.

MATERIALS & METHODS

- The stack gases of the *MSWI* were collected using equipment completely built in glass. Ambient air was sampled at the four sites A, B, C and D (*Figure 1*), selected on the basis of meteorological information in order to evaluate the potential impact of the MSWI and other local sources.
- Samples were extracted with organic solvents in a Soxhlet apparatus and separated from interfering components in a multistage separation process which included a purification step by an Extralut column (70-230 mesh; Merck; Darmstadt, Germany) loaded with concentrated sulphuric acid (98%), and further purification an neutral alumina columns (Merck).
- The 2,3,7,8-chlorine-substituted congeners and the homologues of each chlorination class were detected by a TRACE GC 2000, Thermo Finnigan (Thermo Fisher Scientific), coupled with a Mat 95 XP Mass Spectrometer, operating in the electron impact ionization (EI+) mode, at 10,000 resolution power. International Toxic Equivalent (I-TEQ), with the more recent toxic equivalent factors (TEFs) revaluated by the World Health Organization (WHO) in 2005 (WHO-TEQ_{2005}), have been used.
- Samples related to known emission sources of PCDDs/Fs to include in the PCA matrix were selected on the basis of knowledge of the potential sources in the area. PCDD/F homologue of these samples and of those obtained in the present study were organized into a matrix having n objects (samples) and p variables (PCDD/F homologues values), normalized to the total concentration of PCDD/F by expressing each homologue value as a percentage of the sum of the total PCDD/F before PCA. The Simca - P 8.0 package (Umetrics AB, Umea, Sweden) was used for the analysis.

RESULTS & DISCUSSIONS

- Results for the *MSWI* emission indicate that the PCDF/F concentration range is in each case lower than the emission limit (0.1 ng-TEQ/Nm^3) adopted for the *MSWI* in Italy.
- Average air PCDD/F concentrations expressed as TEQ concentrations, were 0.14 pg/m^3 at the *location A*, 0.05 pg/m^3 at the *location B*, 0.03 pg/m^3 at the *location C* and 0.02 pg/m^3 at the *location D*. Concentrations expressed as sum of PCDDs and PCDFs were 5.6 pg/m^3 at the *location A*, 2.0 pg/m^3 at the *location B*, 1.8 pg/m^3 at the *location C*, 1.2 pg/m^3 at the *location D*.
- Many of the samples collected are characterised by high levels of lower chlorinated furans, tetrachlorinated furans (TCDF) and pentachlorinated furans (PnCDF). This pattern is completely different from the fingerprint of the *MSWI*.
- *Figure 2* shows the average PCDD/F homologue profiles of the first and second campaigns. The profiles of the air samples for all four locations seem different from those collected at the *MSWI* chimney, which had a higher content of PCDDs than PCDFs, whereas the others had a higher content of PCDFs, particularly those from *location A*.
- PCA was done to identify which other sources might be responsible for PCDD/F levels in air samples, particularly at *location A*. Data from the *local steel factory* (provided by the factory itself), air samples from a *road traffic tunnel* (Oehme et al., 1991), emissions from the *MSWI* and air samples from the first and second monitoring campaigns of the present investigation were used.
- *Figure 3* gives the resulting score plot of the PCA, with the samples included in the analysis shown in the space of the first and second component. The samples related to different sources form three clear clusters: the one on the right includes samples of emissions from the *MSWI* (♦); the one on the left includes samples from the *local steel factory* (■) and the third one, in the upper part of the figure, groups samples from *the road traffic tunnel* are located (▲). Thus, PCA makes a very clear distinction between samples from different sources, showing that the three homologue profiles and consequently the type of emission are completely different.
- Air samples from *locations A* (○) and *B* (□) are almost all in the second cluster (steel plant), whereas the remaining air data from *locations C* (◊) and *D* (Δ), are more spread out but still close to the second cluster. Thus this analysis clearly shows that, regardless of the closeness to the *MSWI*, PCDD/F levels in air, particularly for *location A*, where the concentration levels are highest, are mainly influenced by the emissions of the steel plant.

CONCLUSIONS

- The concentrations of PCDD/F at the chimney and in the surrounding air of a *MSWI* were investigated in two different periods. In the first period *MSWI* consisted of two independent incinerating units. In the second period the collection of the samples was replicated when a third incineration unit was also in use.
- The average concentrations of PCDD/F from the *MSWI* were lower than Italian law limit, while average air concentrations were lower or comparable to other urban centers around the world.
- Moreover, this study highlights that air PCDD/F levels in the most contaminated locations are mainly influenced by the emissions of the steel plant rather than *MSWI* and demonstrates the usefulness of multivariate data analysis, such as PCA, to distinguish among these different potential emission sources, which are mainly responsible for contamination. This approach could have positive implications in risk management and in public debate about the actual weight of different potential sources of PCDD/F contamination.

Figure 1 : Map of the area investigated showing the four sampling locations (A, B, C and D), the municipal solid waste incinerator (MSWI), and the steel plant in the industrial area.

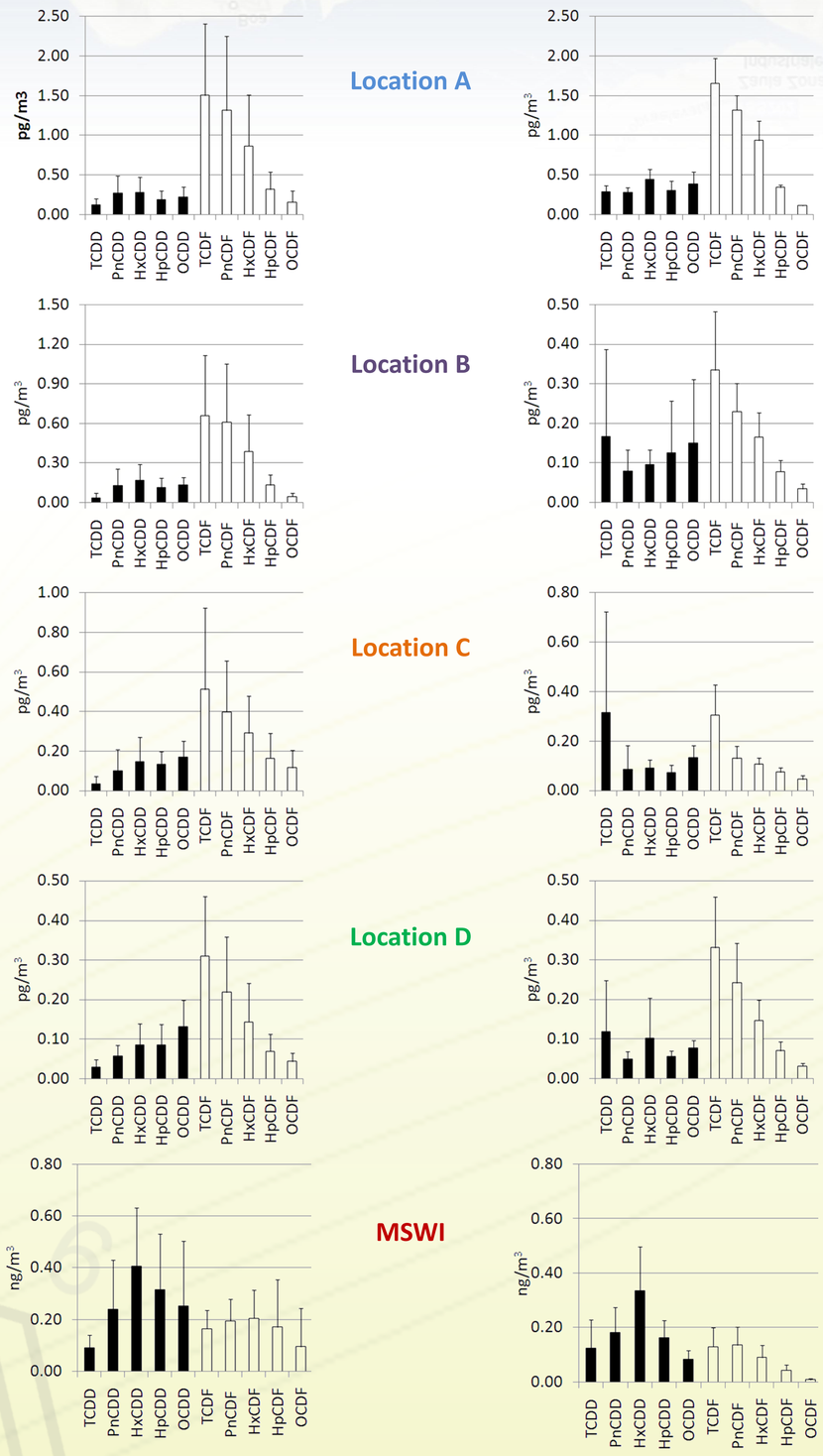

Figure 2 : Average concentrations and standard deviation of each PCCD/F homologue group of samples collected at **locations** A, B, C and D, and at MSWI chimney, in two campaigns.

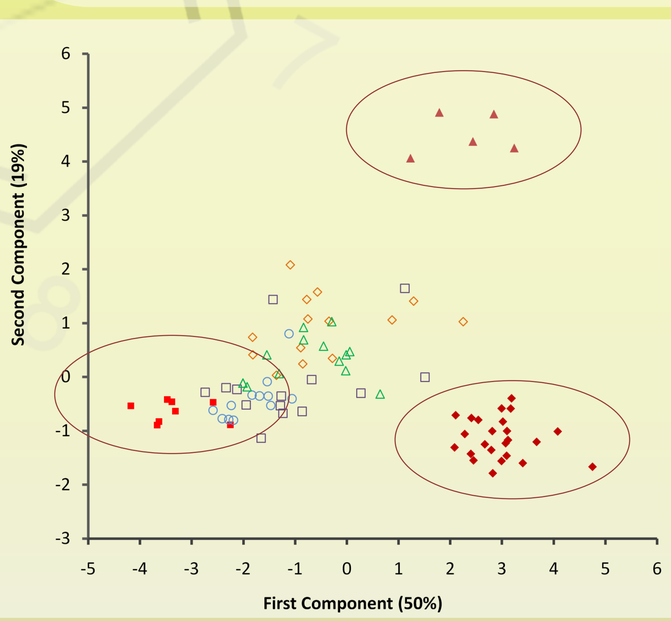

Figure 3 :
Principal Component Analysis (PCA) score plot on the PCDD/F homologue groups of air samples collected at:
location A (○);
location B (□);
location C (◊);
location D (Δ);

and

samples related to known emission sources:
(♦) municipal solid waste incinerator (MSWI);
(▲) air from road traffic tunnel;
(■) steel plant.