Monitoring PCDD/Fs in the Vicinity of an Old Municipal Waste Incinerator, 1996-1998. Part II: Vegetation Monitoring

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Introduction

Combustion to recover energy and reduce the volume of waste that requires landfilling is an important factor in the management of municipal solid waste. However, the emission of trace amounts of metals and polychlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) together with other products of incineration has raised concern about the health and environmental consequences of this process.

While the atmospheric levels of PCDD/Fs vary according to a number of factors such as the prevailing meteorological conditions, the environmental fate and impact of PCDD/Fs are also different from season to season (1). Consequently, the average atmospheric level of PCDD/Fs is not necessarily the best monitor for these environmental pollutants. Although soils are widely used to describe long-term exposure to PCDD/Fs, vegetation can be a more adequate monitor to get information on the short-term exposure to these organic compounds. Moreover, since the presence of PCDD/Fs on vegetation surfaces is due almost exclusively to the uptake/retention of airborne PCDD/Fs, the measurement of changes in PCDD/F concentrations in herbage or leafy crops can be useful to detect changes in air concentrations (2).

In 1996 and again in 1997, the concentrations of PCDD/Fs were determined in soil and herbage samples collected near to an old municipal solid waste incinerator (MSWI) (Montcada, Barcelona, Spain). In the present survey, soil and herbage samples were again taken at the same sampling points and analyzed for the levels of PCDD/Fs. This paper presents the results in herbage samples and a companion paper shows the results in soils (3).

Materials and Methods

In October 1998, one and two years respectively after the first and second soil and vegetation sampling, 24 herbage samples were taken at 100, 250, 500, 750, 1000, 1500, 2000 and 3000 m from the stack in each of the three main directions of the wind in the area (NE, NW, S). The extraction and clean-up procedures, as well as the analytical determination of PCDD/Fs were carried out as previously reported (4,5). Samples were obtained by cutting at a height of approximately 4 cm from the soil and were immediately packed in aluminium foils. Subsequently, they were dried at room temperature, kept in a double aluminium foil, and packed in labelled plastic bags until PCDD/F analysis. PCDD/Fs were determined by GC/MS. Kruskal-Wallis test and Principal Component Analysis (PCA) were used for data comparison.

Results and Discussion

In the present study, PCDD/F concentrations in herbage samples ranged from 0.40 to 1.94 ng I-TEQ/kg (dry matter), with median and mean values of 0.79 and 0.90 ng I-TEQ/kg (dry matter), respectively. In the 1996 survey, PCDD/F concentrations ranged between 1.07 and 3.05 ng I-TEQ/kg (dry matter), with median and mean values of 1.88 and 1.92 ng I-TEQ/kg, respectively. In turn, PCDD/F concentrations in herbage samples collected in 1997 ranged from 0.75 to 1.95 ng I-TEQ/kg (dry matter), with a median value of 1.27 ng I-TEQ/kg and a mean value of 1.30 ng I-TEQ/kg.

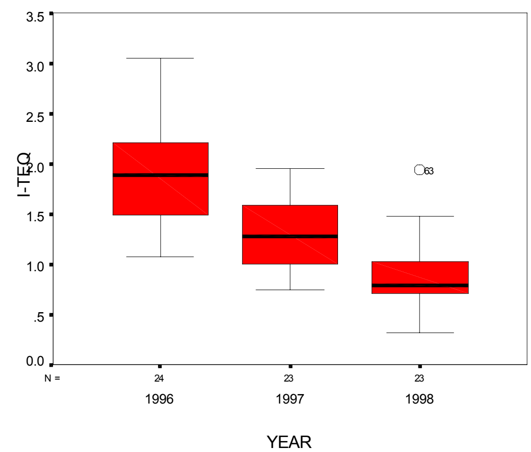

Fig. 1. PCDD/F levels in herbage samples collected near an old MSWI in 1996, 1997 and 1998.

The PCDD/F concentrations (median, quartile and extreme I-TEQ values) in herbage samples for the three collections are presented in Figure 1. The individual comparison between PCDD/F concentrations in the samples collected during 1998 and those taken in 1997 shows a decrease for most of the sampling points (19/23), with an average reduction of 38%. A similar trend was also observed during the previous period, with an average reduction of 32% between 1996 and 1997. The differences in the PCDD/F levels were statistically significant ($p < 0.01$) for both monitoring periods 1996-1997 and 1997-1998.

Figure 2 shows the levels of PCDD/F in herbage samples according to the three main wind directions for the 1996, 1997 and 1998 surveys. In the period here evaluated (1997-1998), PCDD/F concentrations decreased to the three directions: 30%, 25% and 42% at the NE, NW and S directions, respectively. However, the differences were not statistically significant. During the period 1996-1997, PCDD/F levels decreased also at the three main wind directions: 32%, 39% and 27% to the NE, NW and S directions. The decreases were statistically significant at the NE and NW directions.

The levels of PCDD/Fs in herbage samples according to increasing distances from the MSWI are depicted in Figure 3. PCDD/F concentrations decreased between 1996 and 1997, and again between 1997 and 1998 at all distances from the stack. It was especially remarkable at 2000-3000 m, distances for which the differences were statistically significant ($p < 0.05$). Although in the period 1996-1997 PCDD/F concentrations in vegetation were also diminished, the decreases were especially notable at the shortest distances from the plant.

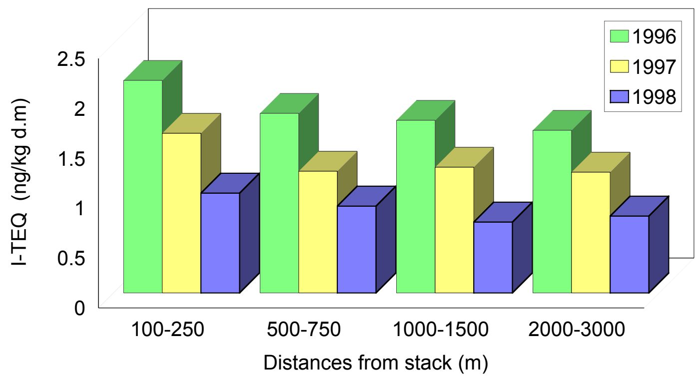

Fig. 2. Concentrations of PCDD/Fs in herbage samples collected at increasing distances from an old MSWI.

PCA provided a two-dimensional model which would explain 59.3 % of the variance in the data (47.4 % and 11.9 % for the 1rst and 2nd component, respectively) (Fig. 4). One sample, taken at 3000 m from the stack at the NE direction, appeared as an outlier.

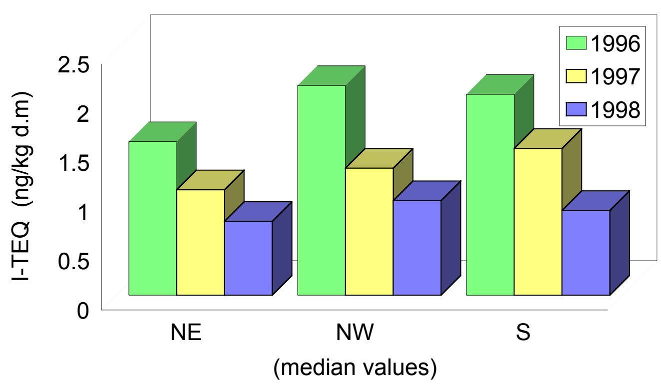

Fig. 3. PCDD/F levels in herbage samples collected in the vicinity of an old MSWI according to the main directions of the wind in the area.

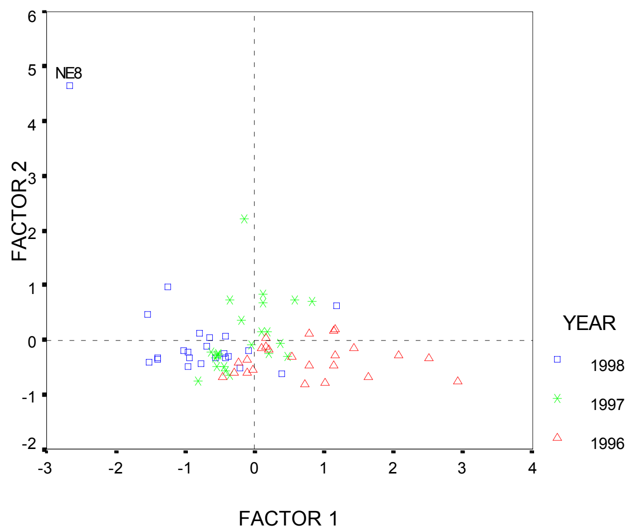

Fig. 4. Principal component analysis: plot for herbage samples collected near an old MSWI in 1996, 1997 and 1998.

The present results show that, in contrast to soils (3), PCDD/F concentrations in herbage samples collected in the vicinity of the MSWI decreased substantially during the last two years. This decline can be explained by general abatement actions for PCDD/F emissions and it reflects the continous general efforts to reduce the environmental levels of PCDD/Fs.

References

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