

CADMIUM CONTENT IN SUSPENDED PARTICULATE MATTER IN ZAGREB AIR

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ABSTRACT

This paper presents the results of cadmium monitoring in total suspended particulate matter (TSPM) in Zagreb air at two measuring sites (city centre and the northern, residential part of the city) for 20 years (1984-2003). Samples of TSPM were collected over 24-hour periods (noon to noon) on membrane filters (Millipore SSWP 09025, pore size 0.8 μm) at the average air flow rate of 70 L min^{-1} , from approximately 100 m^3 of ambient air. Samples were destroyed in nitric acid and cadmium was determined by atomic absorption spectrometry. Over the 20 years of monitoring, the annual means of cadmium concentrations varied from 0.5 to 5.9 ng m^{-3} in the city centre and from 0.4 to 3.1 ng m^{-3} in the residential part of the city. Cadmium concentrations in the residential part were in average 32% lower than in the city centre. However, cadmium concentrations in Zagreb air were below the recommended value (RV) of 0.01 $\mu\text{g m}^{-3}$, according to the Law on Air Quality Protection in Croatia. With respect to cadmium in TSPM, Zagreb air is of the 1st category – clean air (concentration levels of air pollution are below RV).

Key Words: heavy metal, air quality monitoring, atomic spectrometry

1. INTRODUCTION

Cadmium is a heavy metal that can be found in ambient air, dust, food, drinking water, tobacco, smoke and working environment. Cadmium in humans often originates from a combination of these sources. Total suspended particulate matter is one of important cadmium sources in the environment.

Cadmium content in TSPM collected from ambient air was measured in the period 1984-2003 in Zagreb, the capital of Croatia. Zagreb is the city with about 1,000.000 inhabitants; it is a cultural and industrial centre of the region.

The purpose of this investigation was to describe cadmium concentrations, trends, and seasonal dependences and to compare the measurements with the concentration limit values defined by the Ordinance on Recommended and Limit Air Quality Values (Ordinance, 1996).

2. MATERIAL AND METHODS

Two sampling sites were chosen for cadmium investigation, representing the city centre and the northern, residential area of Zagreb (Fig. 1). Samples were collected on a daily basis (noon to noon), totalling at least 200 samples per site and per year.

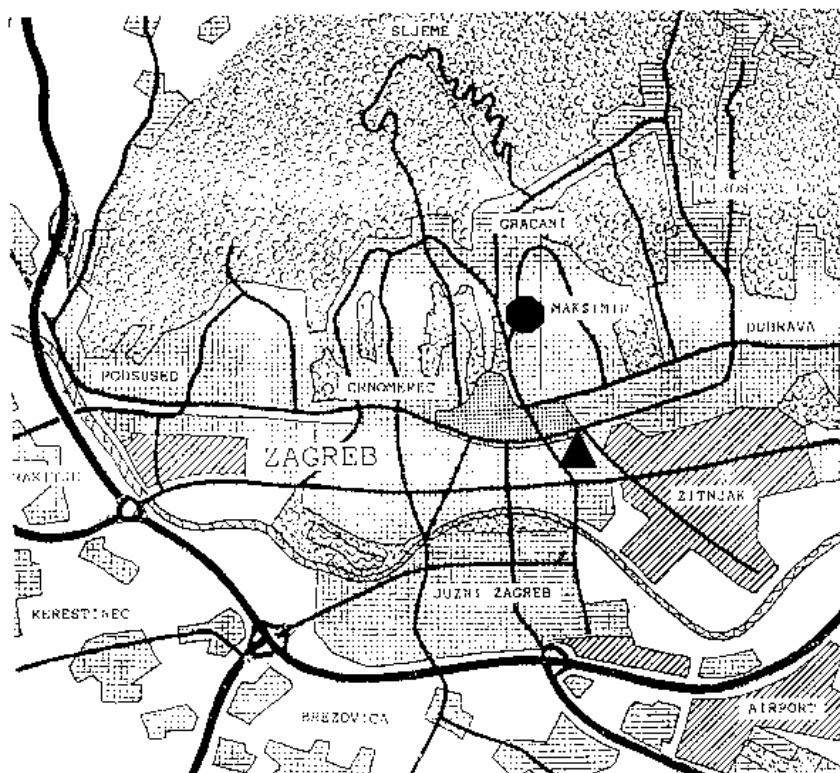


Figure 1. Location of measuring sites (● - city centre, ▲ - northern part of the city)

Total suspended particulate matter was collected on membrane filters, 102 mm in diameter, at an average flow rate of 70 L min^{-1} . Prior to mass determination, before and after sampling, filters were preconditioned in desiccator for a period of 24 hours (Hršak, 1994). The samples were destroyed with nitric acid; the acid was evaporated, and the residue was dissolved in 1 M HNO_3 . Cadmium content was determined using atomic absorption spectroscopy (Solar 969 AAS).

3. RESULTS AND DISCUSSION

Annual mean cadmium concentrations in TSPM in Zagreb air varied from 0.5 to 5.9 ng m^{-3} in the city centre and from 0.4 to 3.1 ng m^{-3} in the residential part of the city. Figure 2 shows annual trends for cadmium in TSPM in Zagreb air at both sampling sites over the entire measuring period (1984-2003). The decreasing trend of cadmium concentrations in TSPM in Zagreb air was observed from 1984 to 2000, and over the last few years cadmium concentrations were below 1 ng m^{-3} .

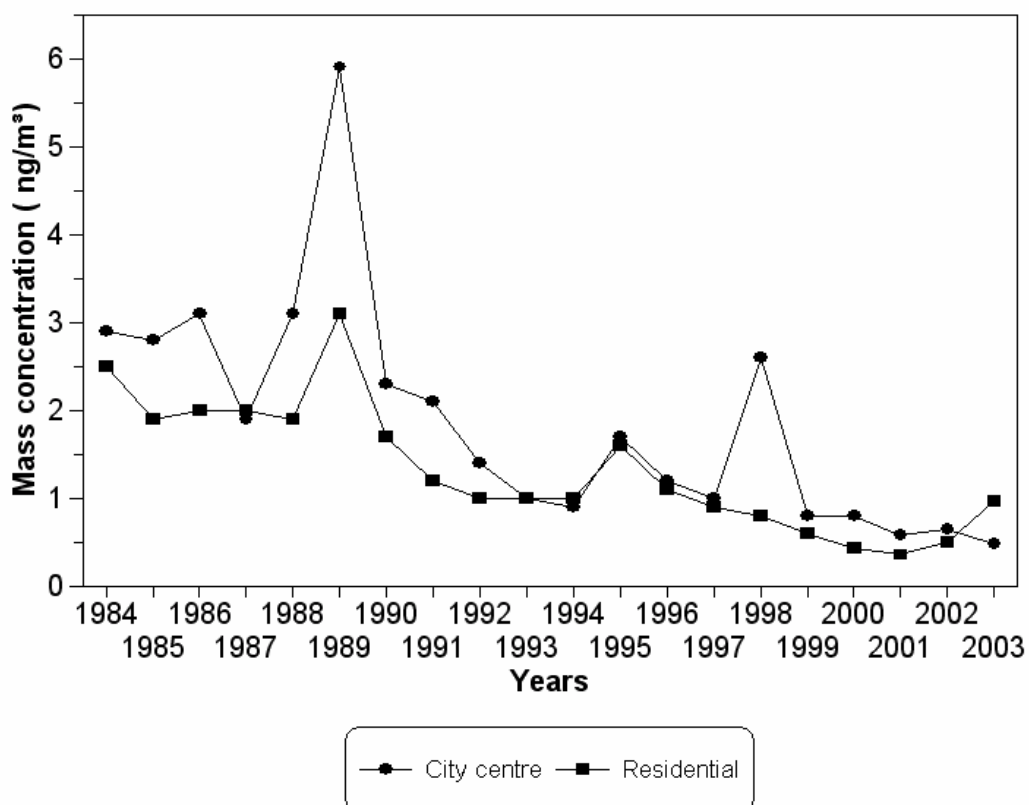


Figure 2. Trend of cadmium in TSPM in Zagreb air

A comparison of cadmium concentrations in TSPM between two sampling sites showed a good correlation ($r= 0.591$). The value of correlation coefficient and the results of regression analysis (Fig. 3) suggest that transport has an important role in cadmium content in the air; namely, cadmium comes with lead, but in much lower quantity. Also, the results in the residential area were in the average 32% lower than in the the city centre with a high traffic density.

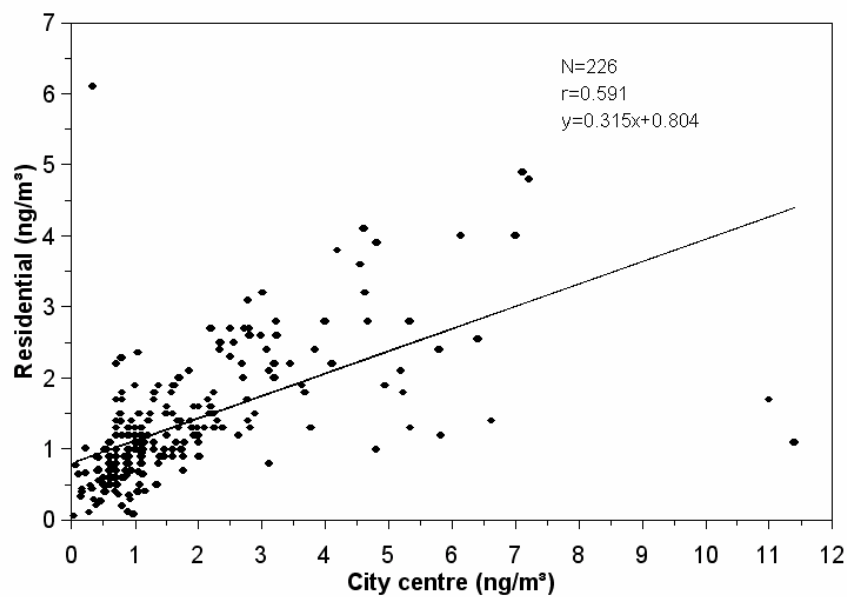


Figure 3. Correlation between cadmium in TSPM in the air in centre and in residential part of the city

Monthly cadmium concentration averages for the city centre and residential area are presented in Figure 4. Generally, monthly averages of cadmium concentrations for the entire measuring period (1984-2003) were low, ranging from 0.98 to 2.9 ng m^{-3} .

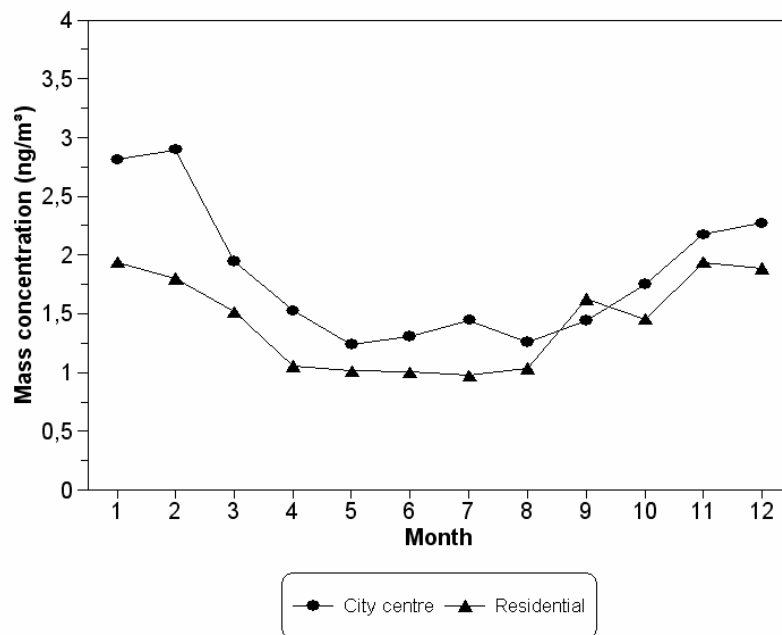


Figure 4. Monthly cadmium concentration averages in TSPM in Zagreb air. Cadmium concentrations in TSPM were higher in winter and lower in summer (Fig. 4). Annual values kept below the recommended value defined by the Ordinance which is for cadmium $0.01 \mu\text{g m}^{-3}$.

4. CONCLUSIONS

In the period 1984-2003, cadmium concentrations in TSPM in Zagreb air were low, below the recommended value. Higher values were measured in winter and lower in summer. Cadmium concentrations in TSPM in the city centre were in average 32% higher than in the residential part of the city.

However, cadmium content in TSPM was very low and the air in Zagreb, according to the Law on Air Quality Protection in Croatia (Law, 1995) was in the 1st category – clean air (concentration levels of air pollution are below RV) throughout the measuring period.

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