HEAVY METAL CONCENTRATION IN URBAN SNOW AS INDICATOR OF AIR POLLUTION

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Abstract

By air pollution we mean the presence of certain substances in the atmosphere that are different from the normal composition of air and depending on their concentration and time of action lead to human health disorders, affect the flora and fauna, or alter the human living environment.

An amount of pollutants discharged into the atmosphere is subjected to a dispersion process that lowers the concentration of pollutants as a function of distance from the source. Concentrations of heavy metals in the snow can be an indicator of air pollution in urban areas, also giving us indications on the origin of pollution. We compared the concentrations of heavy metals in the snow with the background levels to find out if they could be used as an effective indicator of urban air pollution.

Samplings were carried out at road intersections in the center and peripheral areas of Bucharest to determine the influence of road traffic and industrial areas on the air pollution levels. Concentrations of copper, lead and cadmium were determined during sessions of sampling in various locations with low or high traffic density and at different distances from sources of industrial pollution [1].

The concentrations of heavy metals in the snow in peripheral areas were clearly higher as compared with the concentrations in the inner city, as they were influenced by local pollution due to the industrial areas nearby the city, as well as due to the influence of wind on the dispersion of pollutants [2].

The concentrations of copper were generally higher at road intersections with high traffic density as compared with sites of low traffic. This could be due to different driving style, especially braking, as the cars brakes are a major source of pollution with copper. In contrast, the cadmium and lead concentrations remained almost constant regardless of traffic intensity. For cadmium there were found relatively high concentrations even at the road intersections of low traffic. This indicates that, beside the traffic, there may be other important sources of pollution with cadmium[3]..

Thus we can conclude that the concentrations of heavy metals in the snow are a reliable guide for the degree of air pollution and can be used as a simple and effective indicator of urban air pollution.

Keywords: air pollution, heavy metals, snow

1. INTRODUCTION

By air pollution we mean the presence of certain substances in the atmosphere that are different from the normal composition of air and, depending on their concentration and time of action, lead to human health disorders, affect the flora and fauna, or alter the human living environment.

An amount of pollutants discharged into the atmosphere is subjected to a dispersion process that lowers the concentration of pollutants as a function of distance from the source.

Different areas have different ways of dispersion, so the same amount of pollutants discharged into the atmosphere in similar conditions results in achieving different concentrations in soil from one area to another, depending on atmospheric and orographic characteristics of the area.

In terms of climate, Bucharest area falls into the climate of 'Campia Romana' with characteristics of an urban microclimate. In Bucharest city the dominant wind directions are from the north-west, followed by those in the south-west.

Establishing the emission level involves measuring the concentration of pollutants either at the generating sources, or within the outer perimeter of the industrial platform which carries out activities generating pollutant emissions into the atmosphere.

Concentrations of heavy metals in the snow can be an indicator of air pollution in urban areas, also giving us indications on the origin of pollution. By comparing the concentrations of heavy metals in the snow with the background levels one can determine the level of pollution due to industrial activities or road traffic[1].

To see if these could be used as an effective indicator of urban air pollution we analyzed a series of samples of snow from different sampling sites, with different traffic conditions and at different distances from industrial sources of emissions of air pollutants. We took into account wind direction as a major factor in the dispersion of pollutants. The heavy metals analyzed in the snow samples are copper, lead, cadmium.

2. DETERMINING OF METALS IN THE SNOW

Concentrations of copper, lead, cadmium, were determined during two sampling campaigns carried out in various locations with low and high traffic and at different distances from sources of pollution. The industrial activities at these sites comprise metallurgy, metal constructions and metal products industries, including machinery and equipment[2].

To observe the influence of road traffic and industrial areas on pollution levels, sampling of the snow was performed at intersections in Bucharest, inner city and suburbs, and at 30 km from Bucharest, namely Calugareni village located in the south. The wind from the west carries the pollutants towards south. Thus, sampling points were located on the West-South axis[3].

Analysis methods and equipment used

Samples were collected in two sampling campaigns in January and February 2011. The fresh snow was sampled from the newly formed layer of snow within a radius of 30 km.

Precaution was taken to avoid contamination of samples. Samples were taken from the snow at 5 cm above the ground, and sampling staff always wore latex gloves. At each sampling site, sampling was done so that the snow would not be contaminated, therefore untouched snow areas were chosen. The height of the snow layer was consistent with an average of 35 cm[4]. Immediately after sampling, the samples were transferred into polyethylene containers which were then tightly closed and sealed. Samples were kept frozen at – 20 °C in the refrigerator until before analysis. Control samples consisted of deionized water filled in same type of containers at the sampling locations and treated identically as the snow samples[5].

To begin the analysis, samples were weighed; partially melted samples were subsequently moved to a refrigerator to continue melting for a period of up to 12 h.

Each sample was digested with nitric acid and hydrofluoric acid.

The samples thus obtained were analyzed for determination of Pb, Cd, and Cu by atomic absorption spectrometry with atomization in graphite-furnace, on a Varian AA280FS spectrophotometer.

3. RESULTS AND DISCUSSIONS

The results of these determinations are presented in Tables 1, 2 and 3, for the three sampling sites: Table 1 for intersection 'Razoare', Table 2 for intersection 'Aparatorii Patriei' and Table 3 for the remote sampling site at 30 km south of Bucharest (Calugareni village). The results are expressed in micrograms per liter of melted snow.

Table 1. Content of heavy metals in snow at 'Razoare'

Month	**Content of heavy metals in snow**		
	Lead	**Cadmium**	**Copper**
	µg/l	**µg/l**	**µg/l**
January	854	22	284
February	692	28	342
Average	**773**	**25**	**313**

Table 2. Content of heavy metals in snow at 'Aparatorii Patriei'

Month	Content of heavy metals in snow		
	Lead	Cadmium	Copper
	µg/l	µg/l	µg/l
January	946	38	192
February	891	46	188
Average	**919**	**42**	**190**

Table 3. Content of heavy metals in snow at 'Calugareni'

Month	Content of heavy metals in snow		
	Lead	Cadmium	Copper
	µg/l	µg/l	µg/l
January	243	16	94
February	251	18	90
Average	**247**	**17**	**92**

Figure 1 presents the concentrations of Pb, Cu, Cd expressed in µg/l corresponding to the three sampling locations. From the bar chart one can see a decrease in concentrations at the sampling site 'Calugareni' which is located 30 km away from urban traffic and industrial emission sources.

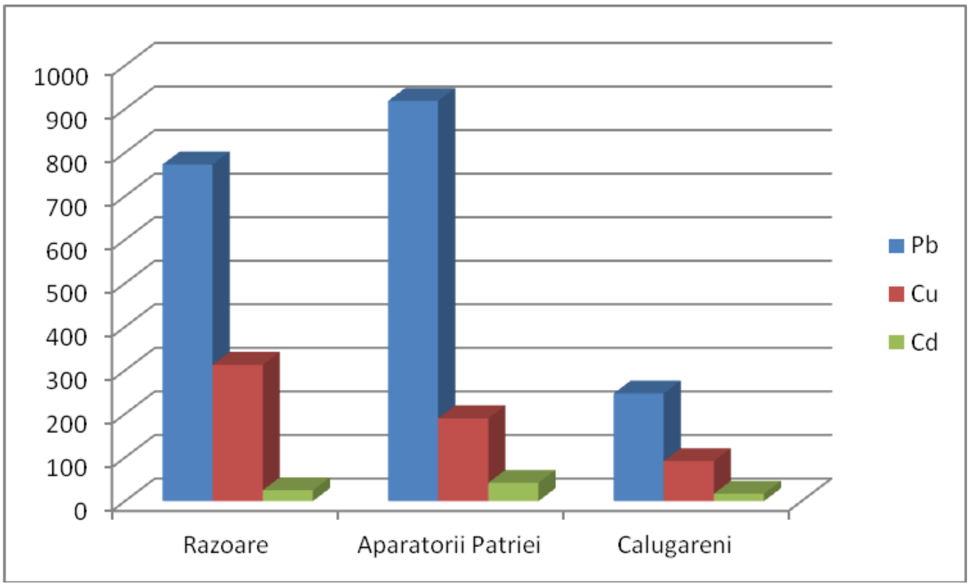

Figure 1. Concentrations of Pb, Cu, Cd (µg/l) at three sampling locations.

Examining the results of the chemical analyses that determined the content of heavy metals in snow samples (collected at intersection 'Razoare', intersection 'Aparatorii Patriei' and 'Calugareni' village in January-February 2011) we can highlight the following observations:

- Lead is found in highest amount in all samples from the three monitored locations, but especially higher at the two locations in Bucharest, which would be an indicator of emissions due to the road traffic;

- Copper is also found in all samples from the three monitored locations in greater quantities than cadmium, but lower than the amount of lead. Copper concentrations were generally higher when traffic density was higher compared to locations with lower traffic.
- Cadmium is present in the smallest amount in the snow samples out of the three heavy metals analyzed, and it is also an indicator of emissions due to road traffic.

The presence of large amounts of heavy metals in the snow indicates heavy traffic as the major source of pollution in the areas considered. However, the industry has also a substantial influence due to its emission sources which may affect the dispersion of heavy metals in atmosphere. Depending on the diameter of particles and atmospheric conditions, the dispersion can extend up to tens of kilometers away.

4. CONCLUSIONS

The concentrations of heavy metals in the snow in peripheral areas were clearly higher as compared with the concentrations in the inner city, as they were influenced by local pollution due to the industrial areas nearby the city, as well as due to the influence of wind on the dispersion of pollutants.

The concentrations of copper were generally higher at road intersections with high traffic density as compared with sites of low traffic. This could be due to different driving style, especially braking, as the cars brakes are a major source of pollution with copper. In contrast, the cadmium and lead concentrations remained almost constant regardless of traffic intensity.

However, presence of large amounts of lead and cadmium indicates heavy traffic as the major source of pollution in the areas considered. Copper concentrations were generally higher in intersections with high traffic as compared with sites of low traffic.

Different concentrations of metals in snow from different areas of the city may have several causes, among which the most plausible are:

- variations in traffic intensity;
- being located in the areas adjacent to emission sources of heavy metals;
- specific features of soil composition in these areas.

Thus we can conclude that the concentrations of heavy metals in the snow are a reliable guide for the degree of air pollution and can be used as a simple and effective indicator of urban air pollution.

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