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Assessment of heavy metal contents in the ambient air of the Coimbatore city, Tamilnadu, India

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ABSTRACT

Industrialization and urbanization are the two major causes of deteriorating air quality. To evaluate the ambient air quality of the Coimbatore city, suspended particulate matter (SPM) was collected at ten stations and analysed for the heavy metals content. The concentrations of seven heavy metals (Zn, Fe, Cu, Pb, Ni, Cr and Cd) were estimated. The level of SPM was found to be either at permissible or non-permissible limit depending upon the category of the sampling station. At majority of sampling stations, concentrations of Zn were found to be maximum than other heavy metals. The order of average concentrations of heavy metals in Coimbatore atmospheric air was Zn > Fe > Cu > Pb > Cr > Ni > Cd. The usage of Zn for protective coating on iron, steel etc. by the industries in Coimbatore city could be the major reason for the higher concentration of this heavy metal in this region.

1. Introduction

Air pollution is caused due to both gaseous (oxides of nitrogen, oxides of sulfur, oxides of carbon etc.) and particulate pollutants (organic and inorganic). Heavy metals are particulate inorganic pollutants released in the atmosphere through natural and man made processes such as metallurgical process, garbage incineration, combustion of fossil fuels, weathering of rocks, mining activities etc. [1–3]. Heavy metals are relatively dense and toxic at low concentrations as they can form complexes or ligands with organic compounds and alter them. These modified biological molecules lose their ability to function properly and resulting in malfunction or death of the affected cells [4]. Heavy metals can be transported from one place to another and released in the ambient air through wind-blown dust [5,6]. Studies in occupation and community settings have established the fact that the accumulation of heavy metals in the body by inhalation or ingestion can be responsible for a wide range of health effects such as cancer, neurotoxicity, immunotoxicity and cardiotoxicity leading to increased morbidity/mortality in populations [7–10]. As the toxic effects of heavy metals are now well recognized in urban places, the determination of their concentrations in the ambient air of major cities is significant in air pollution studies [11–13].

Of the major cities in Tamilnadu state, India, Coimbatore is the second and most important commercial and industrial city. The city and its environs have been growing rapidly and industries like cotton ginning and spinning, foundries and general engineering have converted the Coimbatore city into a major industrial hub of the state. As these activities can add significant levels of heavy metals in the atmosphere, regular surveillance and consistent monitoring of heavy metals present in the SPM collected from the ambient air of the city would be much imperative. Against this background, a study was carried out to determine the atmospheric levels of heavy metals as to clarify the status of the city's ambient air quality and to know the probable sources. The concentration of seven heavy metals (Cd, Cr, Cu, Pb, Fe, Ni and Zn) in the SPM of the ambient air in the Coimbatore city was estimated and the contribution of various sectors like foundries, industries, residential and traffic to the atmospheric metal contents has been evaluated.

2. Materials and methods

2.1. Sample collection

The study was carried out between July 2004 and June 2005. Ambient air samples were collected at ten different locations (Avarampalayam, Chinnavedampatti, Chinniyampalayam, Ganapathy, Keeranatham, Kunnathur, Kuruchi, Papampatti, Peelamedu and Singanallur) representing industrial, residential and traffic areas in and around the Coimbatore city (Fig. 1). Considering the city railway

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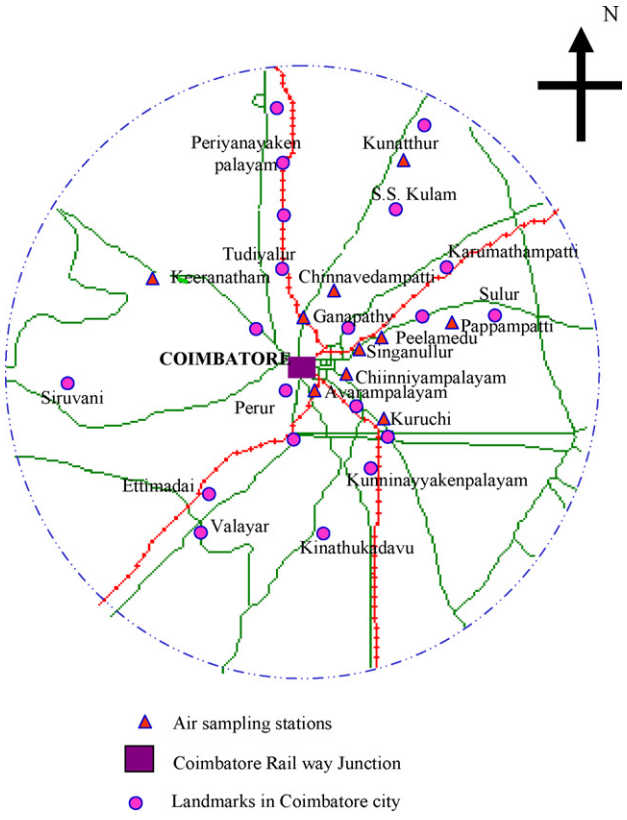

Fig. 1. Location of ambient air sampling stations in Coimbatore city.

station as the centre part, the sampling stations were selected from all directions. The distance between railway station and sampling stations ranged from 4 to 18 km. Using high volume air sampler (Envirotech's APM 415, Envirotech instruments, Upkaran Pvt. Ltd., New Delhi) samples (Sample 1 and Sample 2) each for 24 h were collected from all sampling stations. The sampling details and average flow rate were recorded and carefully maintained through out the study. Daily weather data (relative humidity, temperature, wind speed and wind direction) were obtained from the Department of Meteorology, Tamilnadu Agricultural University (TNAU), Coimbatore. All the collected samples were packed in polyethene covers and transported immediately to the Air Pollution Division, PG and Research Department of Environmental Science, PSG College of Arts and Science, Coimbatore, Tamilnadu, India and analysed for SPM and heavy metals using standard laboratory procedures [14].

2.2. Estimation of SPM

The glass micro fiber filters used in this study were dried in a hot air oven between the temperature ranges of 103 and 105 °C. Subsequently, the SPM collected on the filter paper was estimated following the guidelines mentioned by the United States EPA, Washington, DC [14].

2.3. Extraction and quantification of heavy metals

Sample and control (blank filters) filter papers were processed separately to extract the heavy metals present in SPM by acid digestion. The filter papers were cut into small pieces, placed in a conical flask and added with 10 ml of concentrated H_2SO_4 and 5 ml of HNO_3. Subsequently, it was placed on a hot plate for 2 h, and then it was filtered and diluted to quantify the heavy metals using Atomic Absorption Spectroscopy (PerkinElmer 3100 AA, LA, USA) with sensitivity up to ppb [14].

3. Results and discussion

As a result of excessive urbanization and increased human activities, the air quality has been deteriorated significantly in most of the cities. Air has become a major reservoir of several air pollutants particularly heavy metals [1,2]. Heavy metals are injurious to health as their accumulation in the body may lead to several complications [5,7,8]. Hence, it becomes imperative that the air quality in major urban areas should be monitored consistently so as to characterize the heavy metals composition present in the SPM of the air. This would be helpful to indicate the possible/major sources of SPM to ambient air and to implement remedial and preventive measures.

Table 1
Concentration of test SPM with national ambient air SPM/Pb standards (24 h average)

S. No.	Name of the sampling station	Category of area	Concentration of test SPM (μg/m³)		National ambient air quality standards [15] (SPM[a]/Pb[b] concentration in μg/m³)		
			Sample 1	Sample 2	Industrial area	Residential, rural and other areas	Sensitive area
1	Peelamedu	Residential and traffic area	208	205	500[a]	200[a]	100[a]
2	Keeranatham	Industrial area	116	120	1.5[b]	1[b]	0.75[b]
3	Chinnavedampatti	Industrial area	95	101			
4	Kunnathur	Industrial area	136	139			
5	Kuruchi	Industrial and traffic area	286	279			
6	Avarampalayam	Industrial and traffic area	296	298			
7	Singanallur	Residential and traffic area	303	320			
8	Ganapathy	Industrial and traffic area	292	304			
9	Pappampatti	Industrial and traffic area	168	196			
10	Chinniyampalayam	Residential and traffic area	191	201			

[a] National Ambient Air Quality Standards of SPM.
[b] National Ambient Air Quality Standards of Pb.