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Impact of Vehicular Emissions on the Ambient Air Quality of Srinagar City, Kashmir

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ABSTRACT

This study presents the finding of ambient air quality analysis carried out in Srinagar City, Kashmir. The ambient air quality was analysed for criteria pollutants total suspended particulate matter (SPM), respirable suspended particulate matter (PM_{10}), nitrogen dioxide (NO_2) and sulphur dioxide (SO_2), at 18 different locations of the city. The sampling locations were selected along the road sides to draw a representative profile of vehicular emissions on air quality, covering newly developed as well as highly congested urban centres. The concentration of SPM and PM_{10} was very high as compared to the national ambient air quality standards (NAAQS). Although the levels of NO_2 and SO_2 were well within the standard limits at all the sites, the values of NO_2 were higher at some locations. The present study is a significant indicator of rising pollution levels especially SPM, PM_{10} and to a lesser extent NO_2 in the Srinagar city, mainly due to transportation, construction works and worn out roads. The study suggests that there is a need of comprehensive city management plan including construction of alternative roads, traffic management and implementation of regulations on vehicular emissions. There is also an urgent need for establishing air quality monitoring stations across the city.

Key words: SPM, PM10, NAAQS, pollutant, air quality

INTRODUCTION

Air quality issue is among the most difficult environmental problems due to its impact on human health, climate change, agriculture, and the natural ecosystem (Decker *et al.*, 2000; Molina and Molina, 2004). There has been an unprecedented increase in the human population during the last two centuries, with concomitant industrialization and urbanization. The vast amounts of emissions released from the urban centres have led to significant degradation in the air quality. Concern about air pollution in urban regions is receiving increasingly importance worldwide, especially pollution by gaseous and particulate matter. The air quality crisis in cities is often attributed in large measure (40–80%) to vehicular emissions (Gairola, 2004; Ali and Athar, 2010). Like other countries of the world, air pollution from motor vehicles is one of the most serious and rapidly growing problems in many urban centres of India (CPCB, 2000, Majumdar *et al.*, 2010). The vehicular pollution poses a significant threat to the urban air quality because unlike other polluting industries the vehicles cannot be relocated to the remote areas. Vehicular emissions are of particular concern since these are ground-level sources and thus have maximum impact on the general population (Chelani and Devotta, 2007).

According to the Central Pollution Control Board (CPCB), the levels of primary pollutants- SPM (total suspended particulate matter), PM_{10} (particulate matter of size less than 10μm), sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) are exceeding the stipulated permissible limits for the respective pollutants in most of the Indian cities. The major anthropogenic sources of air pollutants are industrial emissions, domestic fuel burning, emissions from power plants and transportation activities (Reddy and Ruj, 2003). These air pollutants cause adverse effects on health and environment (Kaushik *et al.*, 2006).

In Jammu and Kashmir, like other Indian states, the growing volume of traffic and population in major cities are a major contributor to air pollution. The urban population in the State has showed almost 100% increase during the period 1981 – 2001 contributing about 24.81% to the total population (Census, 2001). Srinagar district, ranking second in terms of total population (989685), has the highest population density (837 persons/km^2) in the State. The number of vehicles in the State has also showed constant increase from 110102 vehicles in 1990 to 621057 vehicles in 2008. Vehicles are estimated to account for 70% of CO, 50% of HC, 30-40% of NOx, 30% of SPM and 10% of SO_2 of the total pollution load in major metropolitan cities of India , of which two third is contributed by two wheelers alone (Gairola, 2004). In the present contribution the ambient air concentrations of SPM, PM_{10}, NO_2 and SO_2 at various road junctions in the Srinagar city has been described.

MATERIAL AND METHODS

The impact of traffic pollution on ambient air quality was studied from April to August during 2007 at 18 different locations along major road junctions of Srinagar city, covering newly developed as well as highly congested urban centres

(Table 1). The sampling apparatus was placed along roadways in downwind direction at a distance of 10m from the edge of the road. Air quality parameters, TSP, PM_{10}, SO_2 and NO_2 were analysed by using High Volume Respirable Dust Sampler (Envirotech Instrument APM 460NL). The sampling instrument was set up on the top of the vehicle (Swaraj Mazda) and sampling was done for 4 peak traffic hours either in morning or evening at each site. The particulate matter (PM_{10}) collected on fiber glass filter was determined by weighing the filter before and after exposure to ambient air. Total suspended particulate matter (SPM) was determined from the sum of PM_{10} and particles larger than PM_{10}. The mass of PM larger than PM_{10} was determined from the initial and final weight of the Cyclone Cup. The collected samples (Fiber glass filter) were properly stored and placed in vacuum desiccators and transported to the laboratory for analysis. The samples of nitrogen dioxide (NO_2) and sulphur dioxide (SO_2) were collected in glass impingers using sodium arsenite and sodium tetrachloro-mercurate absorption solutions respectively. NO_2 in the samples was determined using Jacob and Hochheiser (1958) modified method, while SO_2 was determined using the modified West and Gaeke (1956) method. Samples were kept in a refrigerator until analysis to minimize volatilization.

Table 1. Location of different study sites

Site No.	Location	Site No.	Location
1.	Abi Guazar	10	Kaksari Junction
2.	Batamaloo Junction	11	Karan Nagar
3.	Bemina	12	Lal Bazar
4.	Bishembar Nagar	13	Nishat
5.	Boulvard	14	Qammarwari
6.	Court Road	15	Rajbagh
7.	Darish Kadal	16	Sonwara
8.	Gupkar	17	Soura
9	Hazratbal	18	Syed Hamid Pora

RESULTS AND DISCUSSION

The present study shows that the concentration of SPM, PM_{10}, NO_2 and SO_2 varies greatly from one site to another (Fig 1). The concentration of SPM in Batamaloo junction was the highest at 1167 $\mu g/m^3$ and lowest at Rajbagh (175 $\mu g/m^3$), the mean concentration in the Srinagar city being 423±251 $\mu g/m^3$. Various activities, like vehicular movement, power generation, demolition, spraying, grinding, agriculture and stone quarrying, generate SPM. The automobile exhaust has been found to contain 40–50 $\mu g/l$ SPM, thus high vehicle density in Srinagar

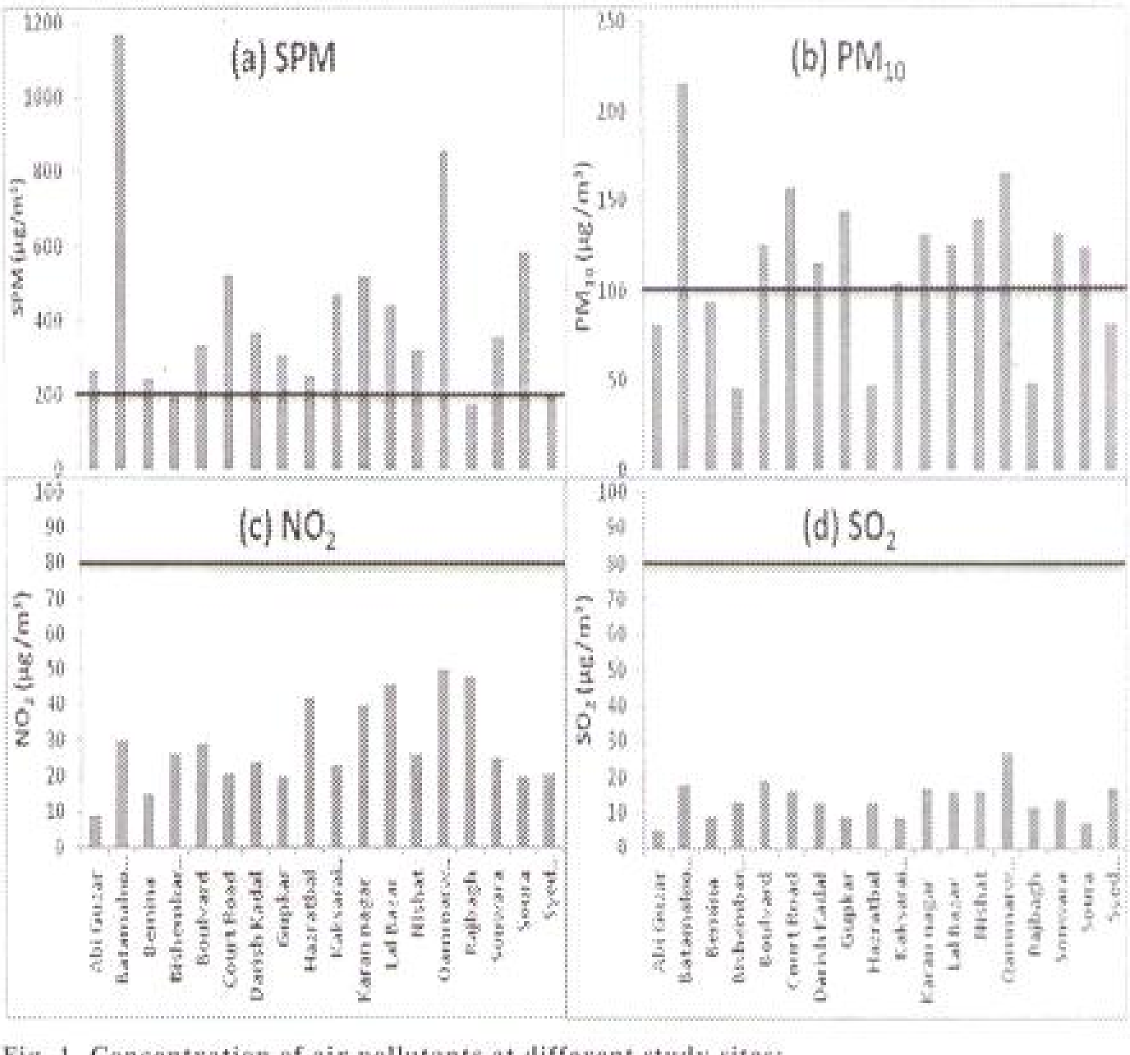

Fig. 1. Concentration of air pollutants at different study sites:
(a) SPM; (b) PM_{10}; (c) NO_2; (d) SO_2. Solid line represents the reference values (NAAQS) of particular pollutant.

city might be resulting in the generation of high SPM load. The SPM values of greater than 500 μg/m^3 (Fig. 1a) were found at Batamaloo Junction, Qammarwari, Soura, Court Road and Karan Nagar which are the busiest locations as for as traffic is concerned with almost frequent traffic jams. Particulate matter in the size range of up to 10 μm is injurious to health is considered as Respirable Suspended Particulate Matter (RSPM or PM_{10}). The PM_{10} concentration at all the stations almost followed the same trend as SPM (Fig. 1b), ranging from a low of 46μg/m^3 (Bishembar Nagar) to a high of 215 μg/m^3 (Batamaloo junction).

The average value of PM_{10} at all the sites was 116±44 μg/m^3. Almeida *et al.* (2007) observed that PM exhibited maximum values in the traffic hours as a consequence of exhaust emissions, wear and tear of tires and brakes and re-suspension of dust. In the present study predominant fraction of PM arises from coarse and fine soil dust being presumably associated with dust re-suspension by road traffic. According to the air quality standards given by NAAQS, almost all the sites exceeded the reference limit 200 μg/m^3 set for SPM. Similarly, the PM_{10} values also exceeded the reference limit of 100 μg/m^3 at most of the sites except Abi Guzar, Syed Hamidpora and Bemina which has PM_{10} values less than 100 ig/m^3 and Bishembar nagar, Hazratbal, Rajbagh which has less than 60 μg/m^3. However, the mean SPM and PM_{10} values for Srinagar city were also above the national standards of 200 and 100 μg/m^3 (24hr) respectively given for residential/commercial areas (Table 2).

Table 2. National Ambient Air Quality Standards for Residential/Commercial areas compared to the mean values of Srinagar city

Pollutant	SPM(μg/m^3)	PM_{10}(μg/m^3)	NO_2(μg/m^3)	SO_2(μg/m^3)
Mean for Srinagar city (n=18)	423(±251)	166(±44)	29(±12)	14(±5)
Annual Average (NAAQS)	140	60	60	60
24 hours (NAAQS)	200	100	80	80

Mean followed by Standard deviation in paranthesis

The sulphur content of diesel is generally assumed to be associated with SPM and SO_2 emissions (Central Pollution Control Board, 1999). Azad and Kitada (1998) reported that the primary source of SO_2 in Dhaka is traffic fuels (55.8%). The NO_2 enters the atmosphere from various natural and anthropogenic sources, including lighting, action of microorganisms on nitrogen-based fertilizer, but the most important and major anthropogenic source is the combustion of fossil fuel in traffic (Salam *et al.*, 2007). NO_2 and SO_2 concentrations (Fig. 1c and 1d) were the highest in Qammarwari (50 and 27 μg/m^3 respectively), and the lowest in Abi Guzar (9 and 5 μg/m^3 respectively). The reason for the low levels of NO_2 and SO_2 at Abi Guzar may be because it is an institutional area with less traffic, low population and less social activities as compared to Qammarwari which has the highest traffic density including both heavy and light motor vehicles. The mean values of 29 ±12 μg/m^3 for NO_2 and 14 ±5 μg/m^3 for SO_2 were observed for all the study sites. Generally lower values of these gaseous pollutants may be due to the restriction of heavy vehicles (Trucks, Buses etc) during the day time in the city.

Although the levels of NO_2 were higher at Qammarwari, Raj Bagh, Lal Bazar, Hazratbal and Karan Nagar as compared to other sites, the values of NO_2 and SO_2 were well within the standard limits at all the sites. It is important to mention here that our values were based on 4 hr of sampling duration and tend to be higher than the 24 hr values. However, the values are a good indication of rising pollution levels, especially SPM, PM_{10} and to a lesser extent NO_2 in the Srinagar city considering the inadequacy of air quality monitoring stations.

CONCLUSIONS

On the basis of the study it may be concluded that transportation, construction and road dust are main sources of air pollution in the city of Srinagar and PM_{10} and SPM are the chief air pollutants in the city, posing health risks either alone, or in combination with other pollutants. There is a need of comprehensive city management plan including construction of alternative roads, traffic management and implementation of regulations on vehicular emissions and installation of air quality monitoring stations to develop an air quality database and air quality standards to protect public health.

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