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ASSESSMENT OF IMPACTSOF VEHICULAR EMISSION ON AMBIENT AIR QUALITY ALONG THE NATIONAL HIGHWAY-32 AT DHANBAD

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KEYWORDS

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ABSTRACT

Air pollutionassociated with vehicular emissions is agrave concern all over the world particularly in urban areas, due torapid growth in number of vehicles.Dhanbad is also worsly affected to air pollution andacquires 20th position among the most polluted cities in India. For the assessment of impact of vehicular emission on ambient air qualityin Dhanbad city, vulnerability analysis (VA) was performedusing average concentrations of SPM, PM_{10}, $PM_{2.5}$, SO_2, NO_X, CO and Pb at four monitoring stations.The average concentrations of SPM, PM_{10}, $PM_{2.5}$,SO_2, NO_X, Co and Pbwere observed to be 448 $\mu g/m^3$, 234 $\mu g/m^3$, 140 $\mu g/m^3$, 20 $\mu g/m^3$, 55 $\mu g/m^3$, 4.25 mg/m^3 and 0.2 $\mu g/m^3$, respectively.The concentrations of SPM, PM_{10}, $PM_{2.5}$ and Co were foundhigher than the National Ambient Air Quality Standards (NAAQS) as prescribed by Central pollution Control Board (CPCB) by the factor of 2.2, 2.3, 2.3 and 1.1, respectively. Among the stations, Shramik Chowk was observed most polluted, which is attributed to heavy traffic load at this traffic junction. From the vulnerability analysis, Shramik Chowk was rated as medium high vulnerable with the vulnerability score of 1715 and the other three stations were classified as medium vulnerable.

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INTRODUCTION

Air pollution has emerged as the most critical problem of the century (Kumar *et al.,* 2011). Vehicular emissions are the most prominent sources of air pollution in urban areas. It contributes to about 40-80% of air quality crisis in citiesin developing countries (Ghose *et al.,* 2005). It is of particular concernin the urban environment due tothehigh probability of exposure to a large population. According to a report bythe United Nations, worldwide 600 million people were exposed to hazardous levels of traffic-generated air pollutants in urban areas (Cacciola *et al.,* 2002). The major pollutants emitted from vehicular sources areCO (carbon monoxide), NO_X (oxides of nitrogen), PM (particulate matter) and VOCs (volatile organic compounds) (Mandavilli *et al.,* 2003).These pollutants have a major long-term impact on ambient air quality. Among these pollutants, particulate matters are of foremost concern because it containsvarious toxic metalsand volatile organic compounds which have adverse health impacts, especially respiratory problems. Particulate matters are closely associated with increases in morbidity and mortality (Maier *et al.*, 2008; Abbas *et al.,* 2009). It is commonly known that these particles carry toxic pollutants such as heavy metals (Gunawardana *et al.,* 2011). Heavy metals associated with respirable particles have been observed to increase lung and cardiopulmonary injuries in humans (Shaheen *et al.,* 2005). Trace amounts of heavy metals are found in fossil fuels and are emitted into the atmosphere by combustion processes, including power generation and emissions from vehicles (Jha *et al.,* 2010).

Recent studies by Dubey *et al.* (2012), Pandey *et al.* (2014), Roy and Singh (2014) have presented the intensity of pollution levels in Dhanbad but the estimation of hazards associated with the pollution levels was missing. Hence, this study was designed with the objective to assess the impacts of vehicular emission on ambient air quality and to estimate the air pollution stress levels in Dhanbad city. For this investigation, four monitoring stations were selected in Dhanbad city along Nationa Highway-32. Among these, three are busiest road intersections and one is Big Bazar where large number of people usually get exposed to air pollution every day.

MATERIALS AND METHODS

Dhanbad is known as the coal capital of India. It lies between 23º37′3" N to 24º4′ N latitude and 86º6′30"E to 86º50′ E. The ambient air quality was investigated (during winter (Jan-Feb) and summer (Mar-Apr) seasons 2015) once a week at four monitoring stations. Among the four stations, three were situated at traffic intersections (Shramik Chowk, RandhirVerma Chowk, Steel Gate) and one along the roadside (Big Bazar) (Fig. 1). Monitoring was done for SPM, PM_{10}, $PM_{2.5}$, SO_2, NO_X,Pb, (24 hour basis) and CO (1 hour).SPM and PM_{10} samples were collected, using respirable dust sampler (Envirotech APM 460 NL) (IS 5182 Part 4, 1999; IS 5182 Part 23, 2006) and $PM_{2.5}$, using fine particulate sampler (Envirotech APM 550 MFC) (CARB, 2002). Theconcentrations of $SO_2$and NO_Xweredetermined by improved West and Gaeke method (IS 5182 Part 2, 2001) and modified Jacob and Hochheiser method (IS 5182 Part 6, 2006), respectively. CO concentration was determined by portable CO sampler(KIMO AQ 200, France). Pbpresent in PM_{10}

was extracted through acid digestion method (method IO-3.1, USEPA, 1999a) and detected by AAS (Katz, 1977) (GBC Avanta PM (detection limit for Pb = 0.01 ppm)) following the method IO-3.2, USEPA (1999b).

RESULTS AND DISCUSSION

The average concentration of particulate matters (PM_{10}, $PM_{2.5}$) was observed higher than the 24 hour national ambient air quality standards (NAAQS) prescribed by the Central pollution Control Board (CPCB) (100 μg/m^3 for PM_{10} and 60 μg/m^3 for $PM_{2.5}$) (CPCB, 2009) across all monitoring stations (Fig. 2). Whereas, the concentrations of gaseous pollutants were largely found below the NAAQS except for NO_x at Shramik Chowk during winter season (92 μg/m^3 against 80 μg/m^3 (24 hour standard)) and for CO at Shramik Chowk, Steel Gate and RandhirVerma Chowk during winter season (7, 6 and 5 mg/m^3, respectively against 4 mg/m^3 (1 hour standard) (Fig. 3).The

Table 1: Vulnerability Index (VI) of the respective Total Vulnerability Score (VST)

Total Vulnerability Score (VST)	Vulnerability Index (VI)
>4420	Very High
4420–3315	Medium High
3315–2210	High
2210–1661	Medium High
1661–1113	Medium
1113–517	Low
<517	Very low

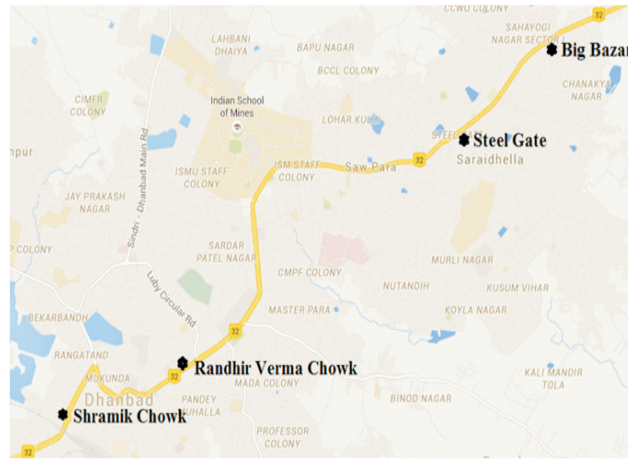

Figure 1: Map of Study Area

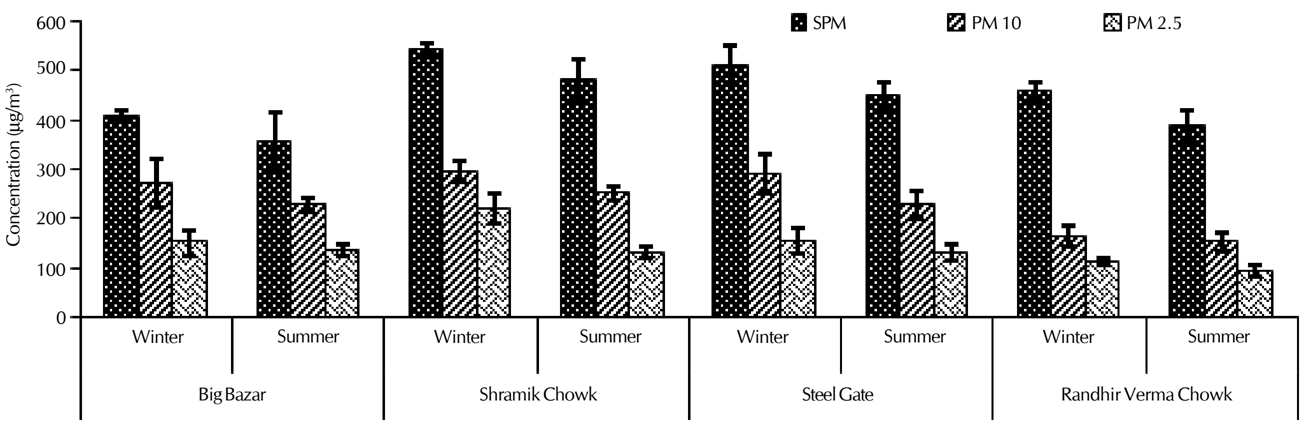

Figure 2: Spatial distribution of SPM, PM_{10} and $PM_{2.5}$ concentrations during winter and summer

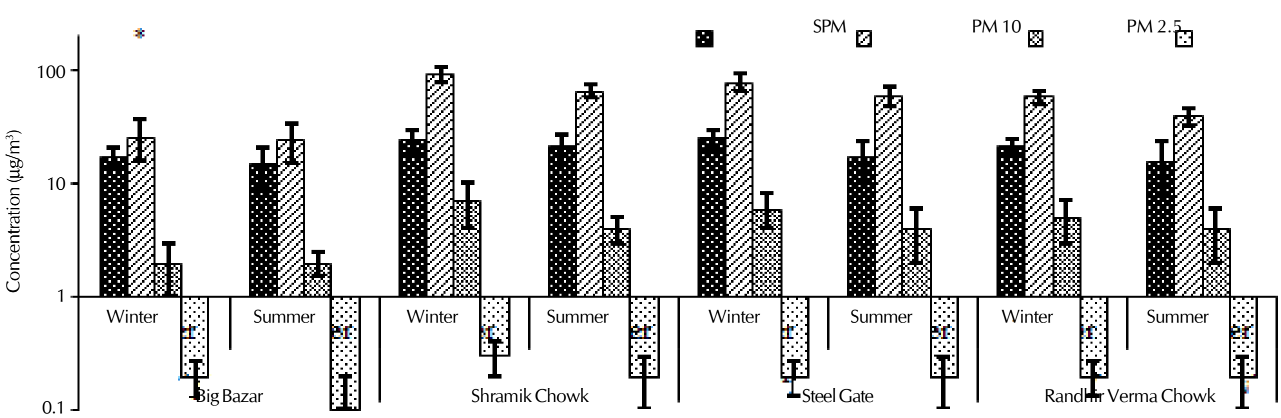

Figure 3: Spatial distribution of SO_2, NO_x, CO and Pbconcentrations during winter and summer

Table 2: Vulnerability analysis at different Monitoring Stations

Sampling Stations	Vulnerability Scores (VS)						VS_T	VI
	SPM	PM_{10}	SO_2	NO_X	CO	Pb		
Big Bazaar	342	572	22	113	80	13	1142	Medium
Shramik Chowk	460	627	32	356	220	21	1715	Medium High
Steel Gate	431	591	29	308	200	17	1577	Medium
RandhirVerma Chowk	378	363	26	218	180	17	1183	Medium

higher observed concentrations of NO_X and CO at these respective stations indicate the strong influence of vehicular traffic. The average concentration of all pollutants was observed higher during the winter season than summer (Fig. 2, 3). Higher concentration during winter is attributed to light winds and limited mixing depth due to a stable or inversion of atmospheric lapse rate (Chaulya, 2004).The ambient concentration of lead (Pb) was observed below the NAAQS throughout the study area which is attributed to phase-out of leaded gasoline in India (Khillare and Sarkar, 2012). The concentration of all pollutants under consideration were observed highest at Shramik Chowk, which is attributed to intense vehicular movement at this road intersection. Because it is the busiest traffic intersection in Dhanbad.

In order to examine the stress levels on the environment as well on human beings due to atmospheric pollution, vulnerability analysis was carried out. Vulnerability analysis was previously used by Ghose *et al.* (2004) to evaluate air pollution stress in Kolkata. Total vulnerability score (VS_T) was calculated from the Equation 1.Where X_i is the concentration of i^{th}pollutantand$T_i$is the toxicity weighing factor of i^{th} pollutant. The values of $T_i$for this study are taken from World Bank (1992). $T_i$values of Lead, NO_X, PM_{10}, SO_2, CO and Dust are 85, 4.5, 2.3, 1.4, 0.04 and 0.9, respectively.

$$VS_T = \sum_{i=1}^{n} X_i T_i \quad \text{...(1)}$$

The vulnerability index (VI) was calculated on the basis of different thresholds of total vulnerability index as depicted in Table 1.

For this study, the averageconcentration of pollutants (Jan-Apr) is used for the calculation of VS_T at each monitoring station. The vulnerability index (VI) of three stations wasobserved medium and of one station (Shramik Chowk) was perceived as medium high(VS_T = 1715) as represented in Table 2.The witnessed vulnerability index indicates the need of appropriate pollution abatement measures along the road networks of Dhanbad.

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