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AIR QUALITY OF DHAKA CITY: A CASE OF VEHICULAR POLLUTION

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Abstract: Air pollution is causing a serious threat to public health in most of the urban centers of developing countries including Dhaka of Bangladesh, which is one of the most polluted cities in the present world. The road users in Dhaka city frequently complain about headache, eye and skin irritation and breathing problem. The research has find out that the situation is expected to be worsening further with the increase of population, economic development and high influx of people from rural areas to urbanized Dhaka. Motor vehicle is increasing at 5% per year in Dhaka, which is the most significant source of air pollution. The paper has analyzed the vehicular population structure and trends in Dhaka from 1990 to 2000 along with the role of different types of motor vehicle in this trends. The analysis show that *2-wheeler* vehicle, car and taxi and *3-wheeler* occupied 45, 22 and 12% respectively in 1992; while those were 38, 26 and 16% respectively in 2000. It is observed from the results that total NO_X (Oxides of Nitrogen) emission in 2000 was 31903 tones and among them *3-wheeler* vehicles, diesel trucks, and cars and taxis respectively contributed 44, 33 and 11%, while the total SO_X (Oxides of Sulfur) emission was 19386 tones; and emitted by 58% and 17% from diesel truck, and car and taxi respectively. Finally, the research recommends several strategies for vehicular emission control with the aim of improving existing air quality in Dhaka.

Key words: Air quality, air pollution, vehicle, SO_x, NO_x, Dhaka

Introduction

Atmospheric pollution from traffic vehicles in the urban area is a major problem of the developing countries all over the world. Transportation is a vital tool to a nation's economy. Motor vehicle is the most important tool for transportation. In Dhaka city of Bangladesh, this transportation tool is not only providing the movement of goods and human all over the city but also the main source of air pollution. The most concerning pollutant species producing from this transportation tools are NO_X and SO_X. Both of these species concentration goes very fast in the city due to high influx of people from different parts of the country. Rapid increase of population requires high transportation demand, which is the most significant cause of NO_X and SO_X pollution in Dhaka.

The environment of Dhaka has been deteriorating rapidly during the last couple of years. The road users frequently complain about headache, eye and skin irritation and breathing problem. The situation is expected to be worsening further with the increase of population, economic development and high influx of people from rural areas (Ullah, 2002). Motor vehicle, which is increasing at a rate of about 5% per year in Dhaka, is the most significant source of air pollution (WB, 2000). Emissions from traffic vehicles are about 55% responsible for severe NO_X and SO_X pollution in Dhaka (Azad, 1998; Azad and Kitada, 1998a). But only a few studies have been conducted on the traffic pollution in Dhaka (Nath, 2002; Azad and Kitada, 1998b; Kitada and Azad, 1998; Karim *et al.*, 1997), and those studies were limited to a particular episode or season. In this study, a detail analysis has been performed on the patterns and trends of vehicle population as well as their contributions in the air pollution of Dhaka city between 1990 and 2000.

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Materials and Methods

Structure of traffic vehicle in Dhaka city: Dhaka city is being more urbanized to meet the excess demand of the coming people from different parts of the country. This excess people force to build up infrastructure to their basic needs as well as the number of automobiles for transportation demand. Running motor vehicles in Dhaka can broadly be classified into six categories (DUTP, 1996): (i) Car and taxi, (ii) Jeep, station wagon and microbus, (iii) diesel bus, (iv) diesel truck, (v) *3-wheeler* vehicle, and (vi) *2-wheeler* vehicle.

The trends and patterns of vehicle population of Dhaka city between 1990 and 2000 are shown in Fig. 1. Fig. 1 shows the regular rising of vehicles in the city due to high influx of people from different parts of the country to meet their transportation demands. The total number of vehicles rapidly changed within these 10 years from 142,414 to 233,781 in 1990 and 2000 respectively. The rate of increase of car and taxi, *3-wheeler*, and *2-wheeler* were significant in the last 10 years. The reasons for increase of these types of vehicle are economic development, influx of people coming from different parts of the country, and opportunity for less educated people in Dhaka. Thus, due to high rate of population growth in Dhaka, transportation demand gradually increases, and those enhance the vehicles growth and change the distribution of their population as shown in Fig. 1.

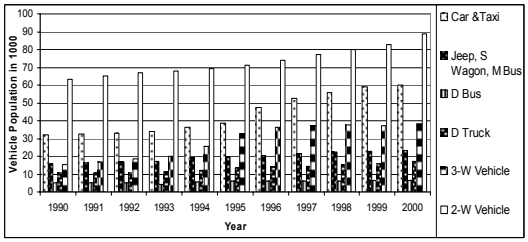

Fig. 1. Traffic vehicle population in Dhaka city in 1990-2000 (Source: Bangladesh Road and Transport Authority, 2001).

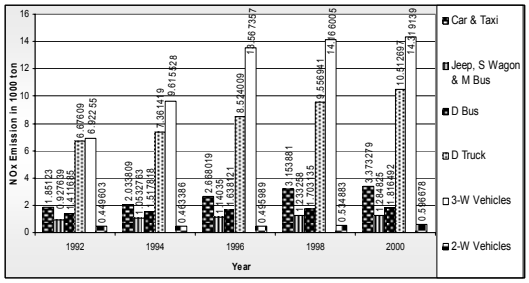

Fig. 2. Trends and patterns of NO_X emission from different types of vehicle in Dhaka in 1992 – 2000.

Estimating fuel consumption by traffic vehicles: Fuel consumption by traffic vehicles is calculated by using annual distance covered by each vehicle, fuel economy and vehicle population. Fuel economy and annual distance traveled data are taken from DUTP (1996).

***Estimation of pollutant emission from traffic vehicles*:** Pollutants emissions from traffic vehicle are calculated by using fuel consumption and emission factors for the unit consumption. The emission factors are adopted from Azad and Kitaka (1998a), and Kato *et al*. (1997).

Results

NO_X Emission: The trends and patterns of NO_X emission from different types of vehicles in Dhaka from 1992 to 2000 are depicted in Fig. 2. The average annual rate of increase of NO_X emission was approximately 13.87% during 1990–2000. The figure also illustrates that *3-wheeler* and diesel trucks are mainly responsible for NO_X emission. Among the vehicle population, *2-wheeler* occupied the highest rank (Fig. 1). By comparison of the vehicle population with NO_X emission, it is found that *2-wheeler* vehicle has insignificant contribution to NO_X emission although its population occupies the highest rank. There is a positive relationship ($r = 0.97$) between vehicle population and NO_X emission (Fig. 3). The first point of the Fig. 3 represents the total number of vehicle population and total amount of NO_X emission from each of them in 1992 and the second point for those in 1994 and so on. It could be concluded that the rapid increase of vehicle population enforces the increase of NO_X emission in the mentioned period.

***SO_X emission*:** In this study, the contributions of SO_X emission from different types of vehicle are estimated and analyzed. The major role-played for SO_X emission in Dhaka city is diesel truck, which occupies the first rank although it is small in population in comparison to other vehicles. The main reason is that diesel truck carry heavy load that results high fuel consumption rate and its emission factor is high too. The contributions to SO_X emission from different types of vehicle also vary to their yearly basis population change. The analysis of SO_X emission trend shows that the average rate of increase of SO_X emission in Dhaka was 10% per year during 1990 - 2000.

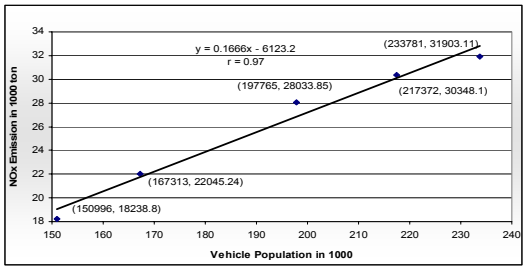

Fig. 3. Relationship between vehicle population and NOx emission (1992-2000).

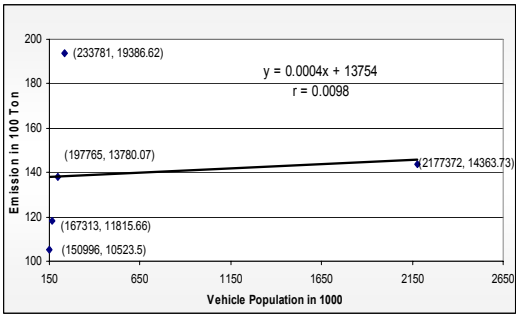

Fig. 4. Relationship between vehicle population and SO_X emission (1992-2000).

Fig. 4 shows the relationship between traffic population and SO_X emission, and also indicates the slightly positive relationship between them from the year 1992 to 2000. The first point of the figure represents the total number of vehicle population and SO_X emission in the year 1992 and other points are for the year 1994, 1996, 1998 and 2000 respectively.

Discussion

***Comparison with other studies*:** Limited published data on Dhaka city are available for the comparison of SO_X and NO_X emission. However, comparisons to the data adopted from the studies of Azad and Kitada (1998a), and Karim *et al*. (1997) are shown in Table 1. In this study the calculated SO_X emission compares very well to those of Azad and Kitada (1998a) and Karim *et al*. (1997). However, the estimated NO_X emission is slightly higher than those of two other study results. Because Azad and Kitada (1998a) assumed that all traffic vehicles used diesel oil as fuel, which has lower emission factor for NO_X compare to petrol and octane (Azad and Kitada, 1998a).

Table 1. Comparison with other relevant studies (base on SO_X and NO_X emission).

Studies	SO_X emission (t/d)	NO_X emission (t/d)
This study	38	60
Azad and Kitada (1998a)	40	38
Karim *et al*. (1997)	42	42

Mitigation Strategies for Traffic Pollution

***Proper traffic management*:** Pollutant concentration can be reduced by avoiding stop-go traffic, particularly near the residential and shopping areas. Many researchers and scientists recommended that traffic needs to be regulated by restricting certain roads for light vehicles, proper maintenance of roads, appropriate location of traffic signals, synchronization of signals located very close to each other, proper planning of traffic islands etc.

***Fuel quality improvement/alternative fuels*:** Diesel oil used by traffic vehicles in Dhaka content high proportion of sulfur, about 1.44%, which has to be reduced to 0.5% (Kitada and Azad, 1998). One of the most important processes to remove sulfur from fuel is through hydrodesulfurization (HDS). HDS is a process commonly used to reduce sulfur content from fuel by converting sulfur compound into hydrogen sulfide. Pollutants emission from automobiles can be controlled by replacing leaded, petrol and diesel oil. There is a scope for improvement of the pollution from vehicular emission through proper planning of alternative fuel use. Alternative fuel includes Compressed Natural Gas (CNG). In the earlier study, Kitada and Azad (1998) showed that substituting natural gas for diesel oil for vehicles could reduce ambient SO_2 concentration by 50- 90% and NO_2 by 20- 45% in the city centers of Dhaka. NO_X emission from traffic vehicle can be controlled by Exhaust Gas Recirculation (EGR) and Catalytic Converter Package. Particulate air pollution from motor vehicles could be controlled using filter package (Kitada and Azad, 1998).

The most crucial component in the exhaust pollution control strategy is stringent vehicular emission standards. Government should enrich DOE (Department of Environment) with adequate technical support for extensive monitoring of vehicular emission within the city. Regularity in monitoring will aware the vehicle owners to maintain exhaust gas emission standards by proper maintenance of vehicles.

Conclusion

The patterns and trends of traffic vehicle population as well as SO_X and NO_X emissions from the traffic vehicles in Dhaka city have been analyzed in details in the present study. Analysis of vehicle population structure shows that the proportion of *2-wheeler* vehicle is the highest, which was 45% of total vehicle population in 1992. A significant increasing trend for Car and taxi, and 3- wheeler vehicles were found in the analysis. Estimation of pollutants emission in the period 1990-2000 from traffic vehicles found that *3-wheeler* vehicle, diesel truck, and car and taxi are the major contributor to NO_X emission in the city. The analysis of vehicular SO_X emission from 1990 to 2000 indicates that diesel truck is the most significant contributor. It is essential to take effective actions for recovering traffic pollution problems. The Government should take appropriate measures for fulfill the future transport demand as well as planning for improvement of existing traffic management, encourage the vehicle owners for using alternative fuels and widely develop monitoring system. These measures will protect the environment from existing deterioration with improvement of transport facility.

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