AIR POLLUTION DUE TO VEVICLE EXHAUST IN DHAKA CITY

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Abstract Limited resources, invested for the development of transport facilities, such as infrastructure and vehicles, coupled with the rapid rise in transport demand, existence of a huge number of non-motorized vehicles on roads, lack of application of adequate and proper traffic management schemes are producing severe transport problems in almost all the urban areas of Bangladesh. Worsening situation of traffic congestion in the streets and sufferings of the inhabitants from vehicle emissions demand extensive research in this field. However, no detailed study concerning traffic congestion and pollution problems for urban areas of Bangladesh has yet been done. Therefore, it has become increasingly important to examine the present state of the problem.

INTRODUCTION

The visible signs of ambient air quality of Dhaka is indicating an upward trend in gross emissions in recent years. Motor vehicles, especially the two strokes engine vehicles (TSEV) are responsible for the increase in emissions of both local pollutants and green house gases due to the rapid growth in the number and use of motor vehicles. The number of registered vehicles in Dhaka has grown by 60% from 1990 to 1996. TSEVs have outgrown all other types of vehicles.

Air pollution in Dhaka is serious due to increasing population and associated motorization. Although existing air quality monitoring data is limited, it has been clearly shown that the average ambient concentrations of suspended particulate matter (SPM) and airborne lead are higher than the Bangladesh national ambient air quality standards and much higher than the WHO guidelines. The city's average SPM levels are about 2 times higher than the Bangladeshi standard of 200 µg/m3 in residential areas and are more than 10 times higher than the WHO guidelines of 120 µg/m3 (24 hours) in commercial areas. Lead levels are also high compared to other cities in the world. Although there is a lack of time-series data, the ambient air quality measurements available for 1990 and 1996 onward indicate that the air pollution is worsening.

Severe air pollution is threatening human health and economic growth in Dhaka. Ostro (1994) and Brandon (1997) estimated that Dhaka encounters 3,580 premature deaths, 10 million restricted activity days and 87 million respiratory symptom days. The economic loss associated with these health problems could range from a low estimate of US$ 60 million to a high estimate of US$ 270 million, equivalent to 1.7% to 7.5% of the city's grows product. If added with traffic jams, global warming, soiling of materials, and asthetic degradation, the total cost of air pollution would be substantially larger.

Present Status

At present, there is little knowledge about the extent of the problem and essentially no air quality management system in place in Bangladesh today to tackle air pollution. Rapid vehicular growth in the metropolitan areas of Bangladesh in recent years has been accompanied by an associated increase in emissions of harmful pollutants. The poor are particularly vulnerable to air pollution, due to above-average physical exposure to air pollution; furthermore, impoverished children suffer from additional effects of air pollution due to malnutrition.

"Air pollution impedes development in Bangladesh. It is estimated that if particulate pollution levels in the four largest cities in Bangladesh were reduced to the standards in force in developed countries, as many as 15,000 deaths, 6.5 million cases of sickness requiring medical treatment, and 850 million minor illnesses could be avoided annually. The economic cost of this avoided sickness and death is estimated to be US$200-800 million per year," says Jitendra Shah, a Senior Environmental Engineer in the World Bank's South Asia Environment Unit. Vehicles constitute the dominant source of air pollution in Dhaka. Two categories of vehicles making significant contributions to overall fine particulate emissions are two-stroke engine three-wheelers and heavy-duty diesel vehicles. As vehicle ownership and use are growing rapidly, the need to initiate pollution control activities is urgent. A large number of pedestrians, drivers, passengers, traffic policemen, street vendors and other groups undoubtedly suffer from significant health damage as a result of exposure to emissions from a large variety of motorize vehicles including two-stroke autorickshaws or "baby

taxis", trucks, buses, cars and two-wheelers.

Pollution in Dhaka city

Dhaka, the capital city of Bangladesh (location 23.42N and 90.22E) has an estimated population of more than 10.5 million with an area of 815 km2. The weather of Dhaka is tropical with lowest temperature varying between 54-790F and highest between 77-950F. During mansoon (June-August), there is very high precipitation of rainfall being on the average greater than 30 cm per month. During winter (November-January), there is hardly any rainfall (<2 cm per month) and there is very little wind. Atmospheric inversion manifested by fog happens quite often. Rest of the year (February-May, September-October) has rainfall between the two extremes.

Air pollution has emerged as a serious problem in the city. Blackening of the city air and reduced visibility can be observed in some areas at times even with unaided eyes. Episodes of choking smells and irritating eyes are common. Dhaka city has heterogeneous traffic flows, as of 1996 an estimated total of 168,718 automobiles are on road. A substantial part of total traffic is non-motorized vehicles enhance severe congestion and pollution problem specially in road intersections. Around 80% of total trips in Dhaka city is comprised of non-motorized transport (NMT) and only 5.9% trips are made by motorized transport (MT). Average trip length of MT is 27 minutes. Trips made by public transport specially buses are very low, only 0.9%. The maximum trips of vehicle modes are made by using rickshaw (a special type of tri-cycle peddled by human) is 43%. Though it is very difficult to quantify pollution contribution from such heterogeneous traffic combinations, the influences of non-motorized transport on pollution are averaged upon the pollution considering the average speed of traffic flows.

Pollution by Two Stroke Engine in Dhaka

There are an estimated 50,000 auto rickshaws in Dhaka, most of them using two-stroke engines. While these vehicles contribute to approximately 35 percent of particles and nearly half of hydrocarbons emitted by all vehicles, it is not feasible to ban two-stroke engine baby taxis overnight.

"Two-stroke engine vehicles need not cause so much pollution, as international experience shows. This is why industrialized countries have not banned two-stroke engine vehicles. Japan, for example, has a large population of two-stroke engine vehicles, but they do not smoke as seen in Dhaka, because they maintain their vehicles and use proper lubricant oils" says Masami Kojima, a petrochemical expert with the World Bank.

Why are two-stroke engine vehicles in other countries so much cleaner than those in Bangladesh? There are two principal reasons: they are maintained regularly, and the drivers use the correct quantity and quality of lubricant. It is the failure to follow these two practices in Bangladesh that is responsible for unacceptably high levels of smoke emissions from baby taxis.

The economic cost of health damage caused by emissions from baby taxis has been calculated to roughly Tk 60 crores (about US$12 million) a year. Good inspection and maintenance practice can help address the problem by reducing emissions by up to 35 percent. Another mitigation measure which need not cost any more to drivers is the use of the correct amount of lubricant designed for two-stroke engines. Currently baby taxis typically use as much as 10 percent four-stroke engine oil with their petrol. By using only 3 percent of quality two-stroke engine oil, they could even save money and at the same time reduce emissions significantly.

Ambient NO2 Concentration in Dhaka

Interest in ambient NOx concentration has increased due to health effects of this pollutant and its important role in the formation of photochemical oxidants; NO2 is also a precursor to species such as nitric acid and nitrate aerosols which contribute to acidification of the environment. In November of 1996, a field study conducted by the author to measure ambient NOx (NO, NO2) concentration in 28 street locations in Dhaka city. Two zones are divided to identify the severance of the problem of NOx. The high concentration locations (black spots), zone I and less polluted areas, zone II. Zone I is identified as the locations where NO2 concentration exceeded 40 ppb, and consequently zone II is those locations less than this level. Among 28 street locations 16 of them identified as the black spots, where NO2 concentration more than 40 ppb. Maximum concentration observed 64 ppb at Malibag area, followed by Bijoynagar 63 ppb, and then Shapla Chattar 57 ppb. The hourly average traffic flow from Mogbazar to Malibag link is 2613 veh/h with an average speed 22 km/h, Paltan to Bijoynagar link 2920 with an average speed 22.85 km/h, and Bijoynagar to Kakrail link 2711 veh/h and mean vehicle speed 24.62 km/h.

SOME INFORMATION ABOUT POLLUTION IN DHAKA

Based on data from different sources and road surveys the traffic pollution contribution in greater Dhaka has been assessed and presented in the following sections.

Table: 1 Motorized Vehicles by Type on Road in Greater Dhaka.

Type/Year	1988	1989	1990	1991	1992	1993	1994	1995	1996	Annual growth (%)
Motor Car	21265	22966	24806	26376	28486	30764	33225	35883	38753	8
Jeep +Station Wagon Microbus	11524	12446	13442	14336	15501	16761	18123	19604	21211	8.1
Taxi	1297	1375	1457	1531	1623	1720	1824	1934	2059	6
Bus	4257	4470	4693	4792	4993	5202	5426	5670	5936	4.2
Minibus	3116	3428	3771	3946	4297	4682	5103	5562	6063	8.9
Truck	8536	9048	9591	9961	10518	11107	11729	12385	13252	5.7
Auto-Rickshaw	10943	14849	15815	18744	20895	23506	26561	30279	34820	14
Motor cycle	19528	21676	24060	26058	29184	30143	34664	39343	45637	12
Others	737	770	789	804	832	861	895	939	985	3.2
Total	81203	91028	98424	106548	116329	124746	137550	151599	168716	8.6

Source: 1. Greater Dhaka Metropolitan Area Integrated Transport Study, working Paper No. 23.
2. BRTA (Bangladesh Road Transport Authority) developed in Cooperation with DITS and BBS.

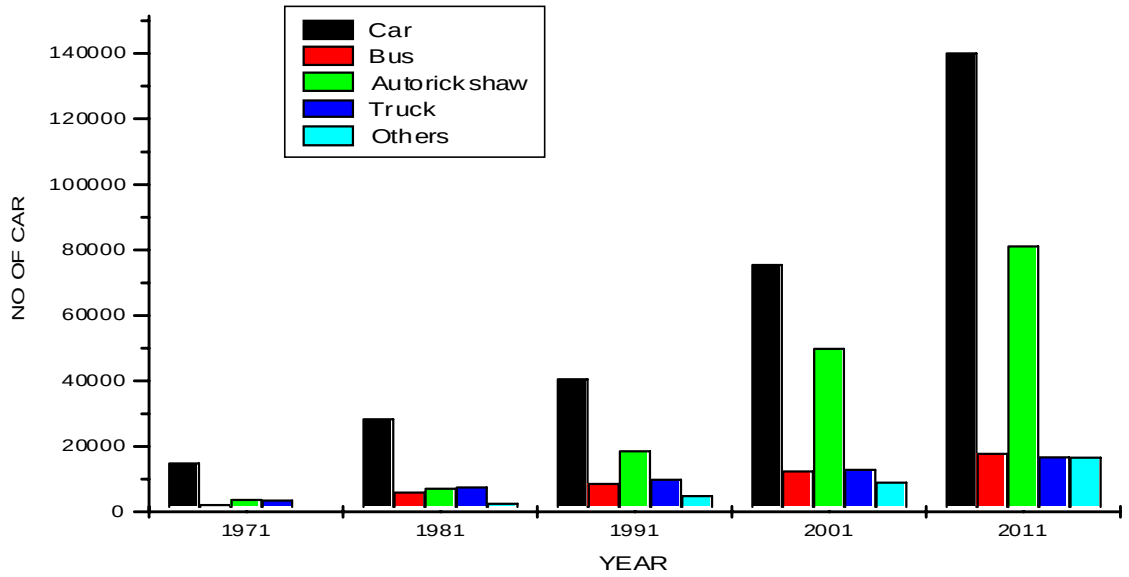

Fig:1. Motorized vehicle in Dhaka city by type.
For year 2001 and 2011 previous rate was considered for estimation.

Table:2 Types of air pollution

Gaseous substances	Gases, vapors SOx, NOx, CO, Ozone, NH3
Particulate matter	Dust, fly ash, smoke, shoot, droplets, mist, fog, fumes, aerosol

Table:3 Lead dispersion and lead in gasoline in Dhaka

Year	Pb in Gasoline	Total lead dispersion
1994	0.4 ng/l	50 tons
1998	0.1 g/l	50 tons
Comment: Situation has not possibly worsened in Dhaka since 1994		

Table:4 Vehicle population, utilization, and fuel economy in Dhaka, 1996

	Vehicle population	Annual utilization (km/yr)	Total annual vehicle kms (millions)	Fuel economy (km/l)
Cars & taxis	42,000	19,200	806.4	8.0
Jeep, station wagon, microbus	12,000	19,200	230.4	8.0
Diesel bus	4,000	57,600	230.4	4.8
Diesel truck	5,000	64,000	320.0	2.4
3-wheeler vehicle	14,500	38,400	556.8	2.4
2-wheeler vehicle	73,500	10,000	735.0	35.0

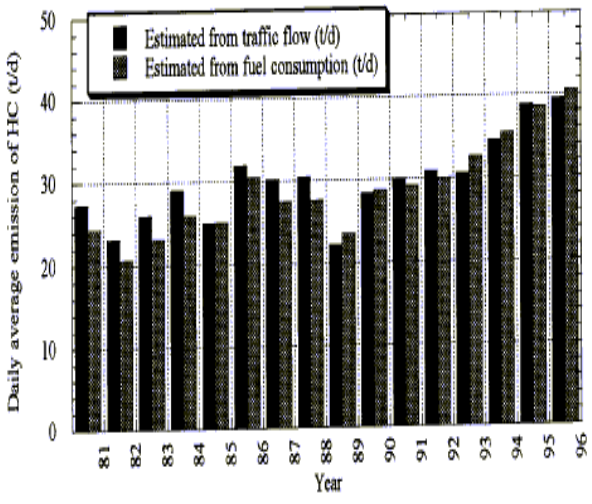

Fig:2 Daily average HC emission in Dhaka.

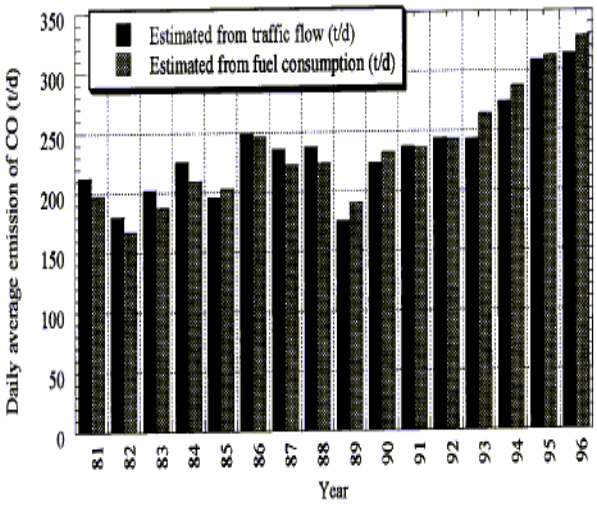

Fig:3 Daily average CO emission in Dhaka

Table:5 Baseline vehicular emissions inventory in Dhaka, 1996; Unit: 1,000 tons

	Particulate matters (PM10)	Hydrocarbons	Carbon monoxide	Nitrogen oxides	Lead	Carbon dioxide	Methane
Light vehicles	0.26	3.70	24.91	1.63	0.012	309	0.04
Minibus	0.21	0.12	0.30	0.58	0.003	115	0.02
Diesel bus	0.64	0.42	1.40	2.65	0	324	0.02
Diesel truck	1.11	0.74	1.91	3.61	0	563	0.03
3-wheeler	0.93	13.52	16.37	0.07	0.011	147	0.19
2-wheeler	0.55	3.31	5.81	0.02	0.011	50	0.11
Total	3.70	21.80	50.70	8.55	0.037	1507	0.40

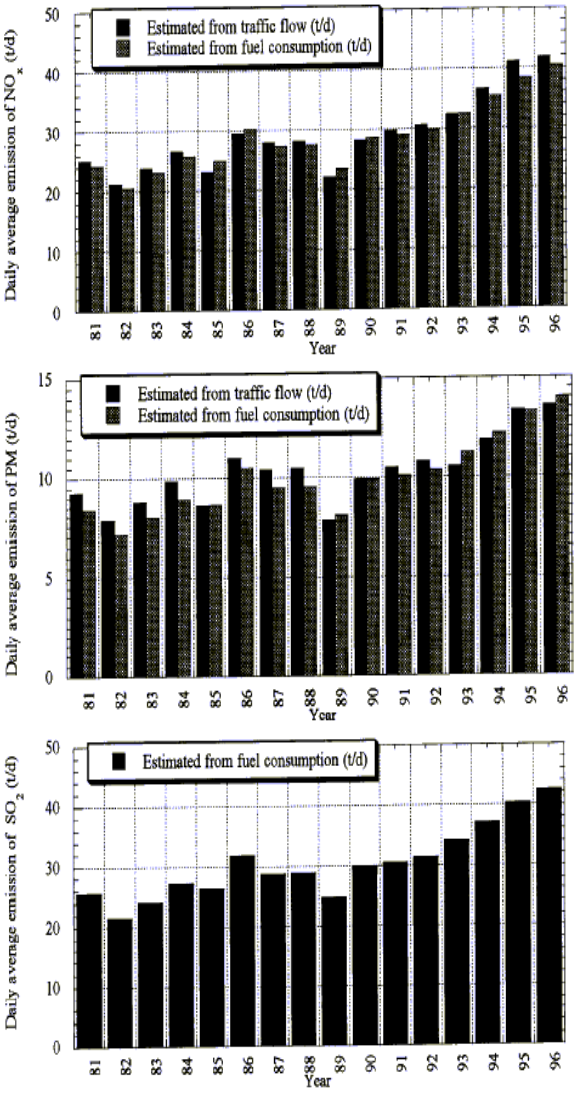

Fig:4 Daly average NOx, SO_2, PM emission in Dhaka.

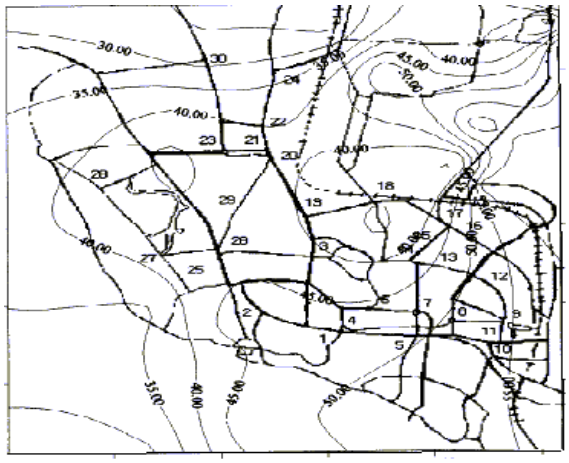

Fig:5. Concentration distribution of Nox at different roads of Dhaka metropolitan (ppb)

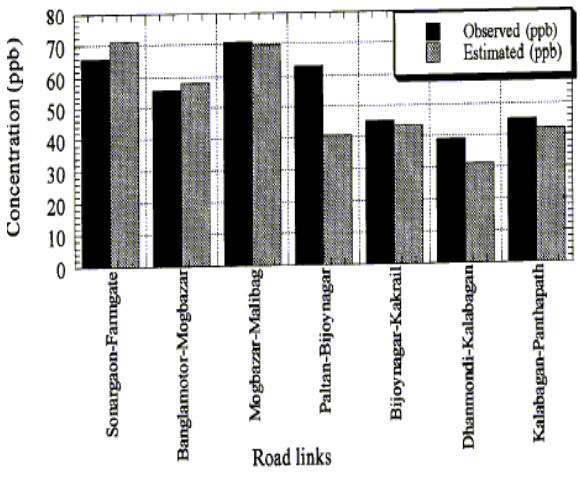

Fig: Concentration evaluation at different road links in Dhaka.

EFFECTS OF POLLUTANTS ON HUMAN HEALTH

Carbon di-oxide (CO2): It is a major absorber of infrared radiation emitted towards the space from the earth surface. Thus, it has crucial role in planetary temperature structure.

Carbon monoxide (CO): If inhaled, it is absorbed from the lung alveoli 300 times faster than oxygen. High concentration of CO in blood makes it difficult for heart to pump blood through arteries.

Hydrocarbons (HC): Unburned hydrocarbon may form ozone with oxides of nitrogen which is a central nervous system depressant. Other hydrocarbons cause convulsion of CNS.

Oxides of nitrogen (NOx): Causes dilatation of air spaces in lungs. NO2 causes damages to bronchioles and alveolar ducts. NO2 is also suspected to impair the defense mechanism of respiratory system. Infants and children are more susceptible.

Particulate matter: Diesel emits suspended particulate matter (SPM) which contains shoot. Shoots are responsible for reduction of atmospheric visibility and absorb and carry organic compound to lungs.

Lead (Pb): Around 75% of the ingested lead is deposited in bones and tissues causing irreversible brain and kidney damage. Growing nervous system of young children are particularly vulnerable.

Suggestions for controlling air pollution

Bangladesh has yet to be implemented a National Air Quality Standard, there are no detail air quality regulations based on which Environmental Impact Assessment could be done. Very few works have been done on air quality measurements and national air pollutants estimates in Bangladesh. BUET should take more extensive project to extend its assistance in doing any projects related to road traffic pollution in Bangladesh. Few recommendations are:

A national steering committee constituting experts is urgently established to cope with the problem. All kinds of automotive vehicle should use catalytic converter to minimize air pollution largely. Bangladesh government should take necessary steps to compel the car owners to use catalytic converter by introducing new laws regarding to air pollution. Formulate guidelines for policy makers, city planners, traffic engineering practitioners towards mitigating traffic pollution problems and make recommendations for setting National Air Quality Standard.

Auto-rickshaw (AR) should be restricted in Dhaka city. Consequently, an equivalent and efficient alternative mode of transport should initiate in Dhaka.What we need is to find an alternative equivalent of AR, that is environmentally friendly and is able to provide door-to-door service.

CONCLUSIONS

The vehicle fleet operates in Dhaka metropolitan are mainly consists of diesel powered vehicles (motor car, bus, truck, auto-rickshaw, and motor cycles).The annual fuel consumption by the vehicles in Dhaka metropolitan is 77% diesel, 18% petrol, and 5% octane. Emissions in Dhaka metropolitan have been increasing at a steady rate since 1990. An average of 6.5% increase in NOx, 5.8% increase in HC, 5.9% increase in CO, 5.6% increase in PM, and 6% increase in SOx emissions have occurred.

Motor vehicles, especially two-strokes engine vehicles are an increasingly important source of air pollution emissions in Dhaka. Further understanding of the sources of air pollution, the contribution of vehicles to air pollution emissions, and the characteristics of vehicular emission control measures is necessary to design a cost effective action plan. It is recommended that government will undertake actual measurement of emission factors, complete the emission inventory, and conduct an investigation on emission control measures.. Government should strengthen vehicle emission standards, regulations and enforcement. Measures to reduce fuel demand and improve traffic conditions are also critical to ensuring a net emission reduction and should be used as a complement to technical measures

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