Country Synthesis Report on Urban Air Quality Management

Bangladesh

Discussion Draft, December 2006

ADB

CLEAN AIR INITIATIVE for Asian Cities

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ADB facilitated this study through its Regional Technical Assistance 6291: Rolling Out Air Quality Management in Asia.

The Study was led by the CAI-Asia Secretariat and the information contained in this report was developed by the CAI-Asia Secretariat with inputs by a range of organizations and air quality experts from across Asia and elsewhere.

Table of Contents

Tables and Figures

Tables

Figures

Abbreviations

ADB	Asian Development Bank
AQ	air quality
AQM	air quality management
AQMP	Air Quality Management Project
BAEC	Bangladesh Atomic Energy Commission
CAMS	continuous air quality monitoring station
CO	Carbon monoxide
DOE	Department of Environment
GDP	gross domestic product
HC	hydrocarbon
km^2	square kilometer
NAAQS	National Ambient Air Quality Standards
NO_2	Nitrogen dioxide
O_3	ozone
Pb	lead
PbB	blood lead (level)
PM_{10}	particulate matter with a diameter of not more than 10 microns
$PM_{2.5}$	particulate matter with a diameter of not more than 2.5 microns
ppb	parts per billion
ppm	parts per million
SAMS	Satellite Air Quality Monitoring Station
SO_2	Sulfur dioxide
µg/dL	micrograms per deciliter
$\mu g/m^3$	micrograms per cubic meter
WHO	World Health Organization

Note: “$” means “US dollar” in this publication.

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» Part One

General Information

Geography and Climate

Bangladesh, with an area of about 147,570 square kilometers (km^2), is located in the tropics between 20°34′ and 26°38′ north latitudes and 88°1′ and 92°41′ east longitudes in South Asia, is bounded by India on the west, the north, and northeast, and Myanmar on the southeast. It is one of the largest deltas in the world formed by the congruence of three Himalayan rivers with a long coastline along the Bay of Bengal. Floodplains (80%), terraces (8%), and hills (12%) cover the land area. Dhaka is the capital city of Bangladesh. It covers an area of 360 km^2 and is one of six municipalities in the middle of the Dhaka Metropolitan Area known as the Capital Development Authority. The city is situated in the populous and flood-prone Ganges-Brahmaputra delta. Dhaka is in effect an island within the delta, especially during floods in the wet season (Asian Development Bank [ADB] 2001).

The country has a subtropical monsoon climate characterized by high temperature and heavy rainfall, and often with very high humidity. The three seasons are distinct—mild winter (November to February), hot, humid summer (March to June), and humid, warm rainy monsoon (June to October). Bangladesh is coldest in late December and early January with temperatures dipping as low as an average of 4 to 7°C. Temperatures then increase toward April where it varies from 27 to 30°C in most parts of the country, except for some areas such as the Rajshahi and Kushtia districts where the maximum temperature rises up to 40°C or more (Asiatic Society of Bangladesh 2006).

Dhaka has an annual average temperature of 25°C and monthly means varying from 18°C in January and 29°C in August. Approximately 80% of the annual average rainfall of 1,854 mm occurs between May and September. Chittagong has a complete tropical monsoon climate with hot, wet summer and dry, cool winter seasons. The average maximum temperatures are between 29°C and 35°C and average minimum temperatures are between 12°C and 17°C. The total annual rainfall throughout the city varies generally between 2, fully 159 mm (85 inches) and 3,048 mm (120 inches). On the average, approximately 80% of the yearly rainfall occurs during the May to September monsoon.

Urbanization and Population

As of mid-2005, 137 million people live in Bangladesh. The population is growing at an annual rate of 1.4%. The population density of 928 persons per km^2 is also among the highest in the world. Urban population share is 25.1% and grows at 3.0% annually (ADB 2006).

In 2000, Dhaka had a population of approximately 12 million. The city also has one of the highest annual population growth rates in the Asian Region as projected by the United Nations. From 1992 to 1999, the city's population grew at an annual rate of 6.4% (United Nations Development Program [UNDP] and World Bank 2002). The port city of Chittagong is the second largest city in the country. Other major cities include Khulna, Rajshahi, Barisal, and Sylhet. These six cities also correspond to the main centers of the country's six administrative regions.

Dhaka is the center of economic, political, and cultural activities in Bangladesh. The city's urban infrastructure is the most developed in the country and has seen in recent years, the modernization of its transport, communication, and public works sectors. As the city attracts more industries, the capital is facing severe challenges such as pollution, congestion, and supply shortages. Chittagong is the second biggest city in Bangladesh, next to Dhaka.

Industry and Economy

In the past few years, the Bangladesh gross domestic product (GDP) has been growing at an average of 5.5%.[1] In 2005, GDP growth rate was 5.8%. The main contribution came from the services sector (54.5%), industry (26.3%), and agriculture sector (19.2%). Of these three sectors, the industry sector showed the highest growth at 8.5%, while the agriculture sector barely grew at 0.3% (ADB 2006). Although the services sector generates more than half of GDP share, the agriculture sector provides nearly two-thirds of employment in the country (Central Intelligence Agency [CIA] 2006).

Dhaka is a major, cultural, and manufacturing center. The common types of industries in and around the periphery of Dhaka are ready-made garment manufacturing, jute, tanneries, textile, tea processing, fertilizer, cement, paper and pulp, chemicals and pesticides, food and sugar, pharmaceuticals, petroleum refinery, distillery, rubber, plastics, and brick manufacturing, assembling buses, trucks, and motorcycles, assembling radios and televisions (Malé Declaration 2000).

Chittagong's status as a port city has attracted significant industrial development. Most industries have been built near the Bay of Bengal and the Karnaphuli River. Industries include shipbreaking, steel production, food processing, textile, petroleum products, chemical manufacturing, and many others. The Department of Environment (DOE) has classified industrial premises into four categories, ranging from clean to highly polluting. The areas to the north and east of Chittagong contain a good number of brickfields. The kilns use coal, rubber tires, oil, and other products for fuel, resulting in significant emissions and potential impacts on air quality (AQ) in the city.

Energy

Bangladesh is rich in natural gas resources, which supplies most of its energy requirements. The natural gas available in Bangladesh has low sulfur content. As of 2005, Bangladesh had a proven gas reserve of 440 billion cubic meters, of which only about 14.2 billion (3.2%) were produced for energy use (British Petroleum [BP] 2006). Bangladesh has small oil reserves.

[1] Based on annual GDP growth rates 2000–2005 from ADB 2006. Key Indicators 2006.

The country consumed about 17.4 million tons of oil equivalent in 2005, which is 5.9% higher than 2004. Energy demand in 2005 was supplied mainly by indigenous natural gas (73.1%) and oil (22.9%). The remainder is produced by coal and hydroelectric power (BP 2006).

Major consumption of petroleum is in the transport sector (50%), followed by domestic (18%), agriculture (16%), power (10%), and industry (6%). Majority of natural gas is consumed in homecooking, electricity generation, and as a fuel in CNG vehicles (ADB 2005).

Bangladesh has 18 power stations with a total installed power generation capacity of 3.6 gigawatt (GW) fueled mostly by natural gas (94%). The commercial sector consumes most of this electricity.

Access to and availability of electricity is very poor in the country. Only 20% of the population has access to electricity (25% of urban areas and 10% in rural areas). Demand for electricity oftentimes significantly exceeds supply (or production), particularly during summer, so load shedding is regularly practiced in the country. The low supply is oftentimes due to low gas pressures. Lack of electricity supply has resulted in the suspension of industrial production and operations.

Bangladesh is considering the use of alternative sources of energy to provide power to those not covered by conventional grid electricity (ADB 2005). The Government has drafted a renewable energy policy promoting the use of wind power, biomass, and solar energy. Pilot projects demonstrating the use of wind power for pumping, drinking, and irrigation water have been established in the areas around Chittagong. Biomass is a major source of fuel for cooking in the rural areas of Bangladesh but is not used extensively in urban areas.

Transport

The ratio of vehicles to people in Bangladesh is lower when compared with other developing countries in Asia. As of end of 2005, there were only about 850,000 vehicles in Bangladesh, about 45% of which are registered in Dhaka. However, it is also important to note that the registered vehicles are only about 25–50% of the actual vehicles plying the roadways due to a limited enforcement of registration regulations

(Intercontinental Consultants and Technocrats Pvt [ICTP] 2001).

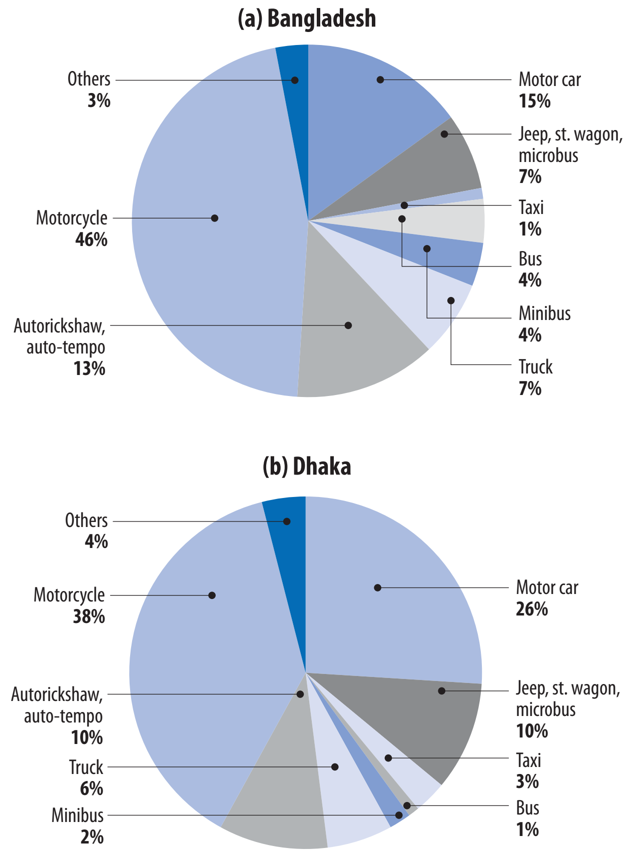
Motorcycles (46%), then motor cars (15%), and auto-rickshaws and auto-tempos (13%) dominate the registered vehicle mix (Figure 1.1a). Almost the same vehicle mix is experienced by Dhaka (Figure 1.1b).

Although Dhaka's vehicle fleet is not large, high traffic volumes, congestion, and poor vehicle maintenance has resulted in the transport sector being a major contributor to air pollution. In addition, inefficient land use and overall poor traffic management further adds to traffic congestion and air pollution. Motor vehicles are often old, overloaded, and poorly maintained. Old trucks and dilapidated mini-buses are also common.

Auto-rickshaws and auto-tempos also make up a significant proportion of the total vehicles fleet. Most vehicles are powered by 2-stroke engines. Two-stroke engine three-wheelers were banned from Dhaka from 1 January 2003 and the Government is planning to introduce similar bans in other cities, including Chittagong.

FIGURE 1.1

Registered Motor Vehicle Mix in Bangladesh and Dhaka, 2005



BRTA = Bangladesh Road Transport Authority; st. = street; % = percent
Source: BRTA.

» Part Two

Sources of Air Pollution

Emissions Inventory

Very limited information on emissions inventory and source apportionment is available. Efforts to compile emissions inventories are mostly limited to mobile sources. There is no national emissions inventory.

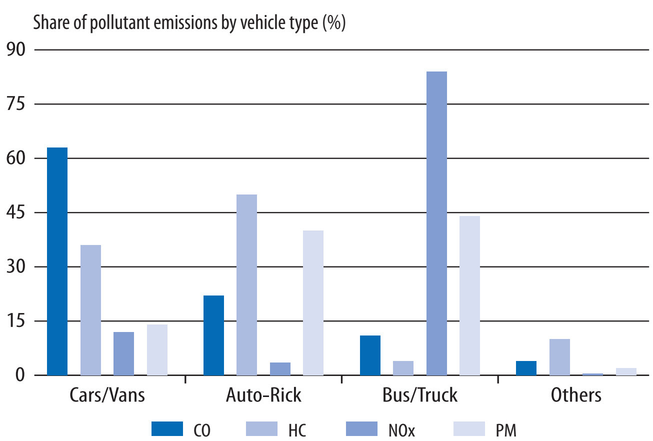
Emissions inventory of mobile sources in Dhaka show that contributions of different vehicles dominate certain types of pollutants (Figure 2.1). Petrol-fueled light-duty vehicles (cars/vans) and auto-rickshaws contribute 85% Carbon monoxide (CO), while diesel-fueled buses and trucks contribute 84%—most of total Nitrogen oxides (NO_x). Two- and three-wheeled auto-rickshaws contribute about half of the total hydrocarbon (HC) emissions, while particulate matter (PM) emissions come mostly from diesel buses and trucks (45%), and auto-rickshaws (40%).

Source Apportionment

The Bangladesh Atomic Energy Commission (BAEC) studied the trace element composition of samples particulate matter with a diameter of not more than 10 microns (PM_{10}) and particulate matter with a diameter of not more than 2.5 microns ($PM_{2.5}$) in Dhaka during 1993–1994, using the positive matrix factorization method (PMF) (Biswas et al. 2000). The results showed that approximately 55% of the particles with diameter not more than 10 microns (PM_{10}) are attributed to resuspended soil and motor vehicle with the latter having a 31% contribution. Fine particulates or particles with diameter not more than 2.5 microns ($PM_{2.5}$) were mostly attributed to motor vehicles (29%) and natural gas/ diesel burning (46%). Table 2.1 presents the complete results showing the eight identified sources.

FIGURE 2.1

Emissions Inventory of Mobile Sources in Dhaka



CO = Carbon monoxide; HC = hydrocarbon; NO_x = Nitrogen oxide; PM = particulate matter; % = percent

Source: Nasiruddin (2006).

TABLE 2.1

Average Mass Contribution to Particulate Pollution in Dhaka, 1993–1994 (%)

Source Type	Coarse (PM_{10})	Fine ($PM_{2.5}$)
Resuspended Soil	54.7 ± 2.4	8.88 ± 5.04
2-stroke engine	6.07 ± 1.8	2.03 ± 3.24
Construction works	7.09 ± 3.36	
Motor vehicles	31.2 ± 6.1	29.1 ± 4.6
Sea salt	0.22 ± 3.69	4.11 ± 2.48
Refuse burning	0.74 ± 5.96	
Natural gas/diesel burning		45.7 ± 8.3
Metal smelting		10.2 ± 8.1

PM_{10} = particulate matter with a diameter of not more than 10 microns; $PM_{2.5}$ = particulate matter with a diameter of not more than 2.5 microns; % = percent

Source: Biswas *et al.,* 2000.

In a follow-up study using the same methodology in 2000 to 2002, BAEC conducted source apportionment in a hot spot and a semi-residential site in Dhaka. The results showed that motor vehicles account for a substantial part of fine particulates for both the hot-spot (43%) and semi-residential sites (38.2%). The results also show that soil dust or resuspended soil account for almost half of the total coarse particulates for the hot-spot site, as well as the semi-residential site. For stationary sources, biomass burning and/or brick kiln manufacturing have a high percentage in the total fine particulates in the hot spot. This can be directly attributed to the number of brick kiln manufacturing areas in Dhaka.

» Part Three

Status of Air Quality

Air Quality Monitoring

Until recently, ambient AQ monitoring in Bangladesh was conducted on intermittent and project basis. In the past, most AQ monitoring efforts were undertaken in the capital city of Dhaka. With support from the World Bank and DOE, Bangladesh now has some capacity to monitor AQ using continuous AQ monitors. DOE has set up four monitoring stations in four divisional towns namely, Dhaka, Chittagong, Khulna, and Bogra. The parameters measured are PM, Sulfur oxides (SO), NO_x, and CO.

Other institutions such as BAEC and the Bangladesh University of Engineering and Technology (BUET) still conduct monitoring of ambient AQ for research purposes. Data from these institutions are published in the form of thesis or publications in international and national journals, which are available for further studies. Some data are also published in leading newspapers and magazines aimed at generating awareness among the citizens (Malé Declaration 2000).

In 2002, a continuous air quality monitoring station (CAMS) was established at the premises of the national Parliament Building, the *Jatiyo Sangsad*, located at the heart of the capital city, Dhaka, under the World Bank-financed Air Quality Management Project (AQMP). Continuous monitors—meeting United States Environmental Protection Agency (US EPA) Federal Reference Method specifications—measures NO_x, CO, SO_x, ozone [O_3]), and methane and non-methane hydrocarbons (NMHCs) continuously for 24 hours. The data are recorded as hourly averages from which 8-hour, 24-hour, and other averaging periods can be generated. The equipment used to measure PM is the PM_{10} inlet equipped high volume sampler for PM_{10} and the Partisol sampler for $PM_{2.5}$. The equipment's performance was validated against the GENT air sampler, for size fractionated air PM used by BAEC (Akhter et al. 2003).

In 2006, another CAMS was set up at the premises of Bangladesh Television Center in the port city of Chittagong. The station also monitors criteria pollutants like SO_x, NO_x, CO, O_3, NMHC, PM_{10}, and $PM_{2.5}$. Similar CAMS will be set up in Rajshahi and Khulna towns and an additional CAMS in Dhaka at hot spots within 2007.

Air Quality Data

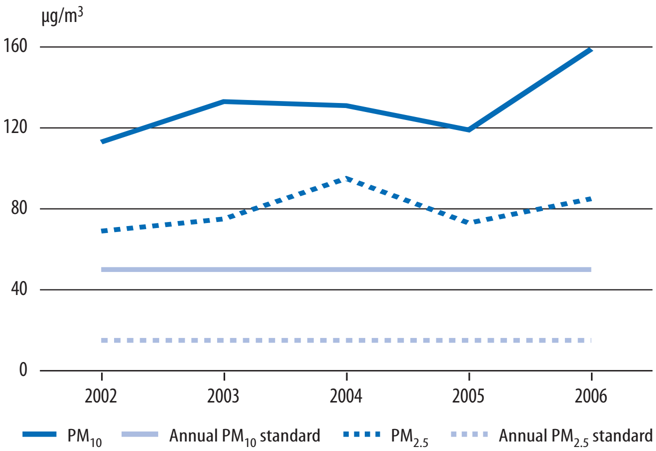
AQ data in the country is available for the capital city, Dhaka. Results of monitoring in other cities are still limited. Since AQ monitoring data has only been consistently gathered at constant locations only for five years in Dhaka, it is insufficient to indicate long-term trends in the AQ of the city, but can only provide indications of tendencies. It has provided enough data, however, to determine variations in AQ based on seasonal changes.

PM concentrations (as PM_{10} and $PM_{2.5}$) on an annual basis in the city of Dhaka indicate a slightly increasing tendency from April 2002 to July 2006 (2002 data is average of concentrations from April to December and 2006 data is average of concentrations from January to July 2006) (see Figure 3.1). Both PM_{10} and $PM_{2.5}$ concentrations exhibit levels exceeding World Health Organization (WHO) guidelines as well as exceed more than twice the national standards of annual PM_{10} (50µg/m^3) and $PM_{2.5}$ (15µg/m^3).

Plotting the average concentrations by month from April 2002 to June 2006 shows a consistent trend in the seasonal variation of PM concentrations. In 2003 to 2006, the highest concentrations of PM_{10} and $PM_{2.5}$ occur in January. High concentrations of PM generally occur from November to February when the country experiences mild winters. On the other hand, concentrations are generally lower from May to September, when most rainfall is received (Figure 3.2).

FIGURE 3.1

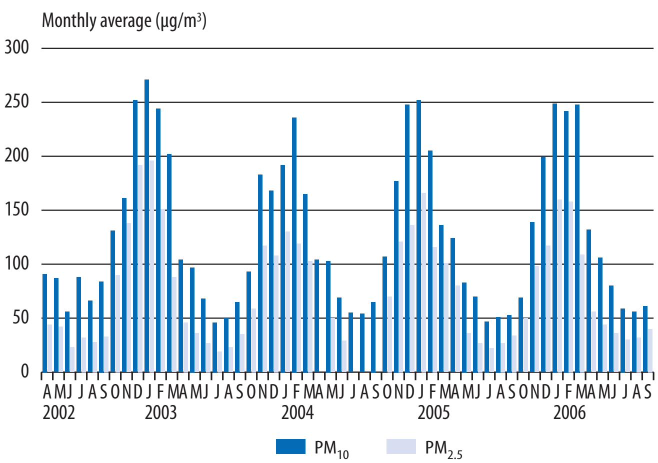
Annual Average PM_{10} and $PM_{2.5}$ in Dhaka



PM_{10} = particulate matter with a diameter of not more than 10 microns; $PM_{2.5}$ = particulate matter with a diameter of not more than 2.5 microns; µg/m³ = micrograms per cubic meter
Source: Nasiruddin, 2006.

FIGURE 3.2

Seasonal Variations in PM_{10} and $PM_{2.5}$ Concentrations

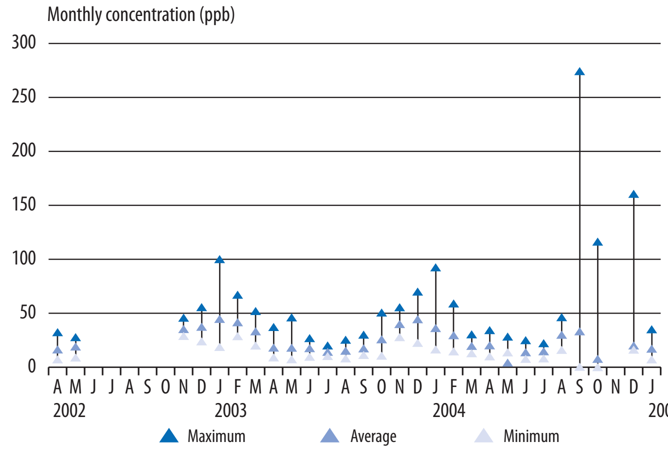


PM_{10} = particulate matter with a diameter of not more than 10 microns; $PM_{2.5}$ = particulate matter with a diameter of not more than 2.5 microns; µg/m³ = micrograms per cubic meter
Source: Nasiruddin, 2006.

Long-term Nitrogen dioxide (NO_2) data are not as available as PM data. To date, there is limited information to indicate long-term annual trend in NO_2 concentrations, but annual average concentration of NO2 for 2003 of 27.6 parts per billion (ppb) will indicate that NO_2 does not exceed annual ambient standards of 53ppb. A seasonal variation is also observed as with PM where NO_2 concentrations are highest from November to February (Figure 3.3).

FIGURE 3.3

Seasonal Variations in NO_2 Concentrations in Dhaka

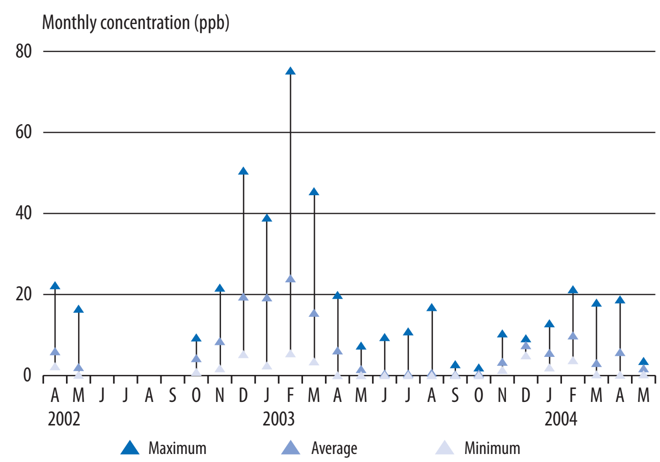


NO_2 = Nitrogen dioxide; ppb = parts per billion
Source: Nasiruddin, 2006.

As with other pollutants, Sulfur dioxide (SO_2) peaks are also observed during the same months starting in November (Figure 3.4). Current available AQ monitoring results do not allow for long-term analysis of annual concentration trends. Annual average concentration for 2003 (6.67ppb) is within the national ambient AQ standard of 30ppb.

FIGURE 3.4

Monthly Concentrations of Sulfur Dioxide in Dhaka



SO_2 = Sulfur dioxide; ppb = parts per billion
Source: Nasiruddin, 2006.

Results from AQ monitoring conducted for other cities are listed under Tables 3.1 and 3.2. Since the monitoring for the different areas were conducted for limited periods only, it is difficult to assess accurately the AQ problem in these cities. The information, however, indicates high levels of PM (in TSP) for other cities.

TABLE 3.1

Results of Ambient Air Quality Analysis at Various Areas in Chittagong (μg/m³)

Place	Date	TSP	SO_2	NOx
Chandgaon residential area	25/02/2003	208.4	20.2	28.3
	02/09/2002	172.6	18.9	20.2
Khulshi residential area	12/03/2003	308.4	42.2	54.8
	14/02/2002	213.1	51.3	60.2
	16/01/2003	312.5	81.6	92.4
	19/11/2002	282.8	46.7	54.4
	10/10/2002	317.8	58.5	61.9
Nasirabad industrial area	11/03/2003	904.0	120.0	128.0
Agrabad commercial area	09/04/2003	804.0	111.0	115.0

NOx = Nitrogen oxide; SO_2 = Sulfur dioxide; TSP = total suspended particulates; μg/m³ = micrograms per cubic meter
Source: ADB, 2005.

Reporting of AQ Information

Bangladesh has adopted an AQ index system to be used for raising the awareness of the public on the quality of air that they breathe. The AQ index for Bangladesh is primarily based on US EPA's system. Ideally, AQI should be made public on a daily manner, however, due to lack of infrastructure and equipment, DOE will initially present the AQI three times a week (Islam 2003).

AQMP reviewed US EPA's AQI system and has recommended this for adoption in Dhaka with some modifications. The number of categories has been reduced from six to four to make the AQI simpler and easily understood. In addition, appropriate Bengali terms were used to describe the AQI categories (AQMP 2003). AQI categories are presented in Table 3.1. These categories are being revised again.

TABLE 3.2

TSP Concentrations in Some Major Cities in Bangladesh

District	TSP range (μg/m³)	Year/ Period of AQ Monitoring
Bogra	170–531	2003–2004
Rajshahi	329–680	2004
Sirajganj	400–420	2003
Pabna	500–829	2004

TSP = total suspended particulates; μg/m³ = micrograms per cubic meter
Source: ADB, 2005.

TABLE 3.3

Proposed AQI for Bangladesh

AQI Range	Category	Color
0 to 100	Good	Green
101 to 200	Unhealthy	Orange
201 to 300	Very Unhealthy	Purple
>301	Extremely Unhealthy	Red

AQI = air quality index
Source: Air Quality Management Project , 2003.

» Part Four

Impacts of Air Pollution

Health

A number of studies have assessed the impacts of air pollution on the health of people in Bangladesh. Most of them, however, were conducted in the capital city of Dhaka.

Air pollution is estimated to be responsible for approximately 3,580 premature deaths, 10 million restricted activity days and 87 million respiratory symptom days per annum. The economic loss associated with these health problems could range from a low estimate of $60 million to a high estimate of $270 million, equivalent to 1.7 to 7.5% of the city's gross product. If added with traffic congestion, global warming, soiling of materials, and aesthetic degradation, the total cost of air pollution would be substantially larger (Xie et al. 1998).

In 1997, a study conducted by the Health Economics Unit of the Ministry of Health and Family Welfare found that the concentration of lead in blood (PbB) among the residents of the metropolis has reached alarming levels. Blood samples of 39 people that were analyzed under the survey were all above the maximum tolerable limit of 10 micrograms per deciliter (µg/dL) recommended by WHO. The concentration levels ranged from a minimum of 13 µg/dl to a maximum of 132 µg/dL. The survey also found that Pb levels in the blood of 12 professionals who attend offices in the Motijheel Commercial Area averaged 55.8 µg/dL. The blood of one motor vehicle driver gave a reading of 86 µg/dL, 6 rickshaw-pullers averaged 46.3 µg/dL, and 11 auto-rickshaw drivers averaged 44.6 µg/dL. In addition, three outdoor laborers had an average of 79.3 µg/dl, one traffic police officer 77 µg/dL, one homemaker 49 µg/dL, two indoor workers 25 µg/dL, and one student 13.6µg/dL (The Independent 1998).

In February 2000, another study determined the PbB levels of children at five primary schools in Dhaka and evaluated the sources of environmental exposure, and potential risk factors for lead poisoning. Selected schools represented a range of geographic and socioeconomic strata. A total of 779 students 4–12 years of age participated. The mean PbB level was 15.0 µg/dL (range 4.2–63.1 µ/dL). Most students (87.4%) had PbB levels above the WHO guideline (10 µg/dL). Among other correlations, elevated PbB levels correlated with children living close to major roads (odds ratio = 2.30; 95% CI, 1.23–4.29. PbB levels measured were similar to those in other countries that use leaded gasoline. Combustion of leaded gasoline is the main source of lead exposure in Dhaka, resulting in ubiquitous contamination of the environment (Kaiser et al. 2001).

In addition, it has been found that Dhaka city has volatile organic compounds (VOCs) exceeding tolerable limits. Emissions from 2-stroke auto-rickshaws were found to contain four to seven times the maximum permissible levels of VOC (DOE 2001).

» Part Five

Air Quality Management

Legislation and Mandate

The primary legislation instituted to mitigate air pollution is the 1995 Bangladesh Environmental Conservation Act (ECA) and the 1997 Environmental Conservation Rules (ECR) (DOE 1997, DOE 2002). DOE, under the Ministry of Environment and Forestry, is the key institution primarily responsible for AQ monitoring and management in Bangladesh. DOE's air pollution responsibilities include the control and analysis of ambient AQ, the identification of polluting industries, and providing support for the implementation of pollution prevention and control. Other core functions and activities of DOE include policy analysis, planning and evaluation of environmental requirements, monitoring and evaluation, compliance and enforcement, and environmental clearances and processing of environmental impact assessments (DOE 2005).

Bangladesh does not have a clean air act or law that specifically addresses air pollution and its management and control. There are no clear indications whether one will be legislated in the coming years. A number of sector-specific policies (e.g., transport and industry sectors) and regulations that impact on air pollution, however, have been adopted.

City-specific action plans, such as the Action Plan to Improve Air Quality developed under the 2001 ADB-funded Urban Transport Environment Improvement Project, have also helped improve the AQM framework in the cities.

Ambient AQ Standards

The first set of ambient AQ standards for Bangladesh was defined in the Environment Conservation Rules of 1997. These 1997 standards were recently replaced by a new set in July 2005 based on the proposal of the World Bank-funded AQM Project which reviewed the old standards. The new standards for PM (PM_{10}, $PM_{2.5}$), NO_2, SO_2, CO, and ozone (O_3) are the same as the ambient AQ standards set by US EPA and the standard for Pb is equivalent to the guideline value set by WHO. Bangladesh is the only country in South Asia which set $PM_{2.5}$ in its National Ambient Air Quality Standards (NAAQS). The standards for CO, NO_2, SO_2, and O_3 are seen to be more lenient than the guidelines set by WHO. Table 5.1 details the updated ambient AQ standards for Bangladesh.

Management of Mobile Sources

The Bangladesh Road Transport Authority has a legal mandate to ensure gross polluting vehicles do not operate on the road network. However, its capacity to carry out this mandate is limited.

Despite this lack of capacity, Bangladesh has relatively made some progress in reducing emissions from vehicles. Management of mobile sources of air pollution in the country is outlined in ECR of 1997. The rules included adoption of emissions standards for gasoline, diesel, and CNG-fueled vehicles. The 1997 standards were reviewed in 2000 under the World Bank-financed Dhaka Urban Transport Project (DUTP). The recommendations of the review were incorporated in the amendments made on the emissions standards gazetted in 2005. The emissions standards for gasoline and CNG vehicles in the country are now equivalent to Euro 2 standards and diesel vehicles to Euro 1 standards.

In response to a heightened awareness of the dangers of lead pollution, the Ministry of Energy reduced Pb content from 0.8g/l to an average of 0.4g/l. The initial plan of banning leaded fuel for 1999 was achieved a year earlier, again due to growing public pressure (DOE 2001). Bangladesh was the first country in South Asia to ban leaded fuel (UNDP/World Bank 2002).

TABLE 5.1

Updated (2005) Bangladesh National Ambient Air Quality Standards vs. WHO Guideline Values and US EPA Standards

Pollutant	Averaging Period	Bangladesh Standards[a]	WHO[b] Guideline Values (µg/m³)	US EPA Standards (µg/m³)[d]
CO	8-hour	10,000 µg/m³ (9 ppm)	10,000[c]	10,000
	1-hour	40,000 µg/m³ (35 ppm)	30,000[c]	40,000
Pb	Annual	0.5 µg/m³	0.5	–
NO_x	Annual	100 µg/m³ (0.053 ppm)	–	–
TSP	8-hour	200 µg/m³	–	–
PM_{10}	Annual	50 µg/m³	20	revoked
	24-hour	150 µg/m³	50	150
$PM_{2.5}$	Annual	15 µg/m³	10	15
	24-hour	65 µg/m³	25	35
O_3	1-hour	235 µg/m³ (0.12 ppm)	–	235
	8-hour	157 µg/m³ (0.08 ppm)	100	157
SO_2	Annual	80 µg/m³ (0.03 ppm)	–	78
	24-hour	365 µg/m³ (0.14 ppm)	20	365

CO = Carbon monoxide; NO_x = Nitrogen oxide; O_3 = ozone; Pb = lead; PM_{10} = particulate matter with a diameter of not more than 10 microns; $PM_{2.5}$ = particulate matter with a diameter of not more than 2.5 microns; SO_2 = Sulfur dioxide; S.R.O. = US EPA = United States Environmental Protection Agency; TSP = total suspended particulates; WHO = World Health Organization; µg/m³ = micrograms per cubic meter; ppm = parts per million; – = no value

Source: [a]S.R.O. No: 220-Law, 2005; [b]WHO, 2005; [c]WHO, 2000; and [d]US EPA, 2006.

In Dhaka, the Government was also successful in reducing air pollution when 2-stroke baby taxis were banned within city limits in January 2003. Some AQ monitoring results have measured decreases in PM_{10} and $PM_{2.5}$ levels in the city after the ban.

Although mandated by law to conduct vehicle testing as a requirement for issuance of fitness certificates, the Bangladesh Road Transport Authority (BRTA) has failed to optimize the use of the five computerized vehicle testing centers (VTCs) that were set up in 2000. Two VTCs built for Dhaka and one each for Khulna, Chittagong, and Rajshahi failed to issue any fitness certificate due to the failure of the contractors and suppliers to hand over the facilities to the Government. BRTA is planning to revive the centers through an ADB loan of 3.5 Taka (Tk) crore ($0.502 million)[1] (Daily Star 2006).

Other intervention measures to reduce air pollution coming from vehicles include the ban on the plying of trucks older than 25 years and buses older than 20 years, promotion of CNG-fueled vehicles, as well as the establishment of standards for lubricants used for two- and three- wheelers.

[1] Taka, abbreviated as Tk is the currency of Bangladesh. One crore is equivalent to 10 million. Conversion is based on rate of 1 US Dollar = 69.78 Bangladeshi Taka from Oracle GL Daily Rates for 6 August 2006. Available: http://forex.asiandevbank.org:8030/fx_rate/forex.jsp.

Management of Stationary Sources

Industrial pollution is a major issue in the major industrial cities of Bangladesh (especially Dhaka and Chittagong). Some monitoring data have already indicated that $PM_{2.5}$ and PM_{10} exceed ambient standards near many industrial stack emissions. In Dhaka and Chittagong, the major source of TSP and other heavy metal pollutants are from brick kilns and cement manufacturing. In Dhaka, over 300 tanneries in a residential area (Hazaribagh) potentially emit significant TSP that may also contain heavy metals like Chromium (ADB 2005).

Even before the enactment of the Environment Conservation Law in 1995, Bangladesh has already established a Brick

Burning Control Act (1989 and 1992) to mitigate emissions from brick kilns (DOE 2001). The 1997 ECR also provided standards for gaseous discharge from industries.

The monitoring of stack emissions and ambient AQ monitoring near an industry, however, is a task not fully implemented due to lack of technical capacity in DOE. Lack of AQ information (emissions and concentration levels) hampers DOE from effectively enforcing industrial regulations.

Public/Nongovernment/ Development Agency Participation

The role of nongovernment institutions such as the academe, international development agency partners, and even the private sector in the improvement of the AQM system of the country is important, especially in raising the awareness and understanding of the public on air pollution. Pressure from the public has helped facilitate the banning of leaded gasoline in the country as well as the removal of 2-stroke baby taxis in the city of Dhaka. The projects funded by development partners have also helped build the technical capacity of the government (e.g., DOE and BRTA) in carrying out its AQM responsibilities.

Academic institutions like BUET, Dhaka University, and Jahangirnagar University that have the capacity for AQ monitoring and analysis help improve the scientific knowledge base of air pollution in the country.

Organizations such as the Forum of Environmental Journalists, Bangladesh Paribesh Andolon, Bangladesh Environmental Lawyers' Association, and the Society for Urban Environment Protection help raise awareness among the people on environmental issues including air pollution through conferences, reports, and ad campaigns.

» Part Six

Conclusion

Based on AQ monitoring results, PM is the main pollutant of concern in Bangladesh, especially in the cold winter months. Motor vehicles and resuspension of soil and road dust are major sources of these particulates as supported by research on source apportionment. The current levels of PM in Dhaka and in other locations are very high and clearly have adverse impacts on the health of the population. The major achievements of Bangladesh in reducing emissions from mobile sources include the ban of leaded gasoline, introduction of lubricant standards, switching to CNG fuel, and banning of baby taxis, old trucks, and buses—especially in Dhaka.

A countrywide AQM system, however, is still lacking in Bangladesh. Although the capacity to manage AQ has greatly improved in the past few years, and a large number of AQ-related activities in different sectors (especially mobile sources) are happening, including the revision of ambient and vehicle emissions standards, an integrated framework for AQM still remains to be a task ahead. AQ monitoring and the compilation of emissions inventories remain as weaknesses.

It is important to expand and improve the AQ monitoring system in the country. Establishing one CAMS in a large city like Dhaka is still insufficient to assess the status of the quality of air fully as well as to monitor the impact of reduction measures in emissions. The lack of information on the positive impacts of measures may undermine the efforts of the Government to improve the quality of air in the country. There is also a need to conduct further studies to understand the impacts of air pollution on health and the environment, to guide policy development.

Although most projects and activities are focused in Dhaka, they have greatly influenced national policy making (i.e., revision of ambient AQ standards and vehicle emissions standards). AQMP in Dhaka is an important initiative that has made significant improvements in the institutional capacity of DOE and BRTA and its expansion to other cities may be expected to make the same positive impact in these cities.

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