Dhaka City

State of Environment

2005

পরিবেশ অধিদপ্তর

BCAS
Bangladesh Centre for Advanced Studies

UNEP

Dhaka City

State of Environment

2005

Prepared on the basis on a study undertaken by:

DEPARTMENT OF ENVIRONMENT
MINISTRY OF ENVIRONMENT AND FOREST
GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH

In collaboration with

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Regional Resource Centre for Asia and the Pacific
(UNEP RRC.AP)

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The relevant information in this report have been collected from different government and non-government organization, published and unpublished documents and through informal communications. The report uses basic data and information up to 2005 to keep harmony among different environmental issues and concerns due to unavailability of data for all sectors.

Edited by:
A. Atiq Rahman
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Executive Director
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FOREWORD

The United Nations Environment Programme (UNEP) is mandated to regularly assess major environmental developments and trends. This mandate has been practically implemented through Global Environment Outlook (GEO) process with global, regional, sub-regional, national and even city-level assessments. The GEO process is participatory, consultative and features capacity building at its core. This gives GEO assessments the necessary scientific accuracy, credibility and authority to provide information for environmental management and policy development to a wide target audience.

The capacity building programme of the GEO process has been highlighted in the Bali Strategic Plan for Technology Support and Capacity Building, an agreed intergovernmental framework to strengthen capacity and provide technology support to developing countries and countries with economies in transition. The implementation of the Bali Strategic Plan is an important opportunity for UNEP to work with partners to strengthen national structures for environmental reporting as a basis for decision making.

The *Integrated Environmental Assessment (IEA) Report of Dhaka* is one of the outputs of UNEP's capacity building programme. The report identifies key environmental issues for Dhaka, including air quality, water resources, solid waste and sewage management, slum squatters and natural disasters. These issues have been analyzed by various experts, including national and city officials, scientists, academics and civil society representatives, to determine their policy making implications. This broad-based participatory process brings national environmental issues to the attention of different stakeholders and to the general public. I hope this report will provide a sound basis for decision making by the Government of Bangladesh and Dhaka Municipality in addressing environmental issues at the policy level and in advancing the sustainable development agenda of the city.

UNEP has also been assisting the Government of Bangladesh to conserve the environment with collaborative activities on environmental monitoring and early warning, capacity building and raising environmental awareness. I would like to express my gratitude to the Government of Bangladesh and associated experts for this fruitful collaboration.

Klaus Toepfer
United Nations Under-Secretary General and Executive Director
United Nations Environment Programme
March 2006

Minister
Ministry of Environment and Forest

FOREWORD

The overall environment prevailing in Bangladesh has been an area receiving prioritized attention of the government. This has made the environmental issues under special focus in various sectors of the national economy and, hence, necessitated undertaking requisite steps toward attaining and ensuring sustainable development. The environment of the Dhaka city, the national capital has, naturally, been receiving prime consideration of the government which, in 2003, undertook a study on the status pertaining to it through a project with financial support from the United Nations Environment Programme Regional Resource Centre for Asia and the Pacific (UNEP RRC.AP).

The above study project, namely, the 'Dhaka City State-of-Environment' was aimed at taking a stock and assessing the quality of the present-day environment of the Dhaka city toward formulating a set of recommendations on augmenting the capacity of the government vis-à-vis environmental assessments, enhancing the quality of planning process with due focus on sustainable development of the city followed by other cities of the country, establishing a strong information networking system and, last but not the least, upgrading the manpower, infrastructural and financial resource-base for the purpose.

I express my thanks to UNEP RRC.AP for their generous financial support toward successful implementation of the project and preparation as well as publication of the report based on the findings of the study envisaged in the project. My special thanks are due to the Department of Environment for successfully accomplishing the task in close collaboration with the Bangladesh Centre for Advanced Studies. Thanks are due also to he Project Management Team for imparting success to the project, to distinguished authors/experts, editors and reviewers for their strenuous endeavor toward making the report user-friendly.

Publication of 'Dhaka City State-of-Environment Report: 2005' will be deemed to have attained its cherished goal if it succeeds in making the politicians, policy makers, decision makers and the general populace at large aware of the prevailing environment of the city, of the early warning of immediate as well as future problems pertaining to it and of the recommendations for reform and corrective measures.

Tariqul Islam

State Minister
Ministry of Environment & Forest

FOREWORD

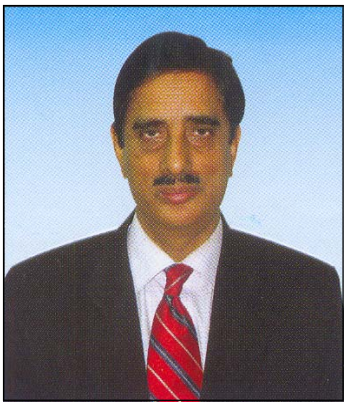
Over the past few years, the environmental status of Dhaka city and its level of pollution concern the government and dwellers of Dhaka. Many of the issues have been considered under the priority action of the Department of Environment, Ministry of Environment and Forests, Government of the Peoples Republic of Bangladesh. A Project was launched with collaboration of UNEF RRC.AP (United Nations Environment Programme Regional Resource Centre for Asia and the Pacific) to prepare the Dhaka City State of Environment report under the aegis of the Ministry of Environment and Forests.

The prime objective of this endeavor is to ensure environmental assessments to improve the planning process taking into account the sustainable development issues and to establish a strong information network.

Dhaka City State of Environment report is intended to make the city planners, decision makers, policy-makers and city dweller aware of the state of environment of Dhaka city and to provide early warning of future problems. The compilation of this report has been a challenging task. It is expected that this report shall provide necessary information to all concerned for better management of Dhaka environment.

I appreciate UNEP RRC.AP for their financial support towards the preparation of this report. My special appreciation are also to DoE for acting as the National Implementing Agency.

Jafrul Islam Chowdhury



Secretary
Ministry of Environment and Forest

FOREWORD

It is a pleasure for me to write this message on the occasion of the publication of "Dhaka City State of Environment 2005". Dhaka has a rich diversity in the context of environmental resources. This includes air, water, land and biodiversity.

Due to rapid urbanization, industrialization, infrastructure development, excessive population growth through both migration and natural increase etc. the environmental situation of the city has become an increasing concern in terms of sustainability. Poverty and inequality in resource sharing among others may be additional factors for environmental degradation in the city.

I hope that this document will serve as a guide to those in the city who are relevant in conservation, management and protection of Dhaka city environment. I also hope that the recommendations of this document will be highly considered by all the development sectors. It will also complement the "Dhaka Environment Programme" published in 2005 with the financial assistance of CIDA by the Department of Environment under the Ministry of Environment and Forests.

I express my thanks to the United Nations Environment Programme Regional Resource Centre for Asia and the Pacific (UNEP RRC.AP) for their financial and technical support in preparation of this report. I must also thank the Bangladesh Centre for Advanced Studies (BCAS) for preparing this document and Department of Environment for providing all kind of technical support to finalize this report.

Barrister M. Hyder Ali

cwi‡ek Awa`ßi

Director General
Department of Environment

FOREWORD

It's my pleasure to have the opportunity to pen a few words on the occasion of publishing this very important document on the State of Environment of Dhaka city "Environment" is now a word of great concern that has created a strong link between economy and sustainable development around the world.

Urbanization, industrialization, agricultural development, land use practices among others have degraded the environment situation in many cities on the world. Dhaka is not an exception. It has become essential to conserve and protect the integral resources of the environment of Dhaka from any natural and man made factors.

I am pleased to note that this initiative of publishing "Dhaka City State of Environment 2005" by the Government of Bangladesh is aptly timed. I hope this document will bear the message of existing environmental situation of the city and also highlight the necessary steps to be taken by the relevant agencies in the development activities.

I express my gratitude to the United Nations Environment Programme Regional Resource Centre for Asia and the Pacific (UNEP RRC.AP) for providing funds to prepare this report. I would like to thank Bangladesh Centre for Advanced Studies (BCAS) for preparing this document.

I anticipate that this document will create a win-win situation in conservation and protection of the city environment through strong coordination of the relevant agencies and will take into consideration the consequences of future development activities in order to minimize negative impact on the environment

Dr. Khandaker Rashedul Haque

ACKNOWLEDGEMENT

The Department of Environment, Ministry of Environment and Forest, Government of the People's Republic of Bangladesh wishes to thank the distinguished individuals, researchers, authors/experts and institutions who have actively participated in the study and made valuable contribution in preparation and publication of this treatise, namely, 'Dhaka City State-of-Environment Report : 2005'. Such individuals, researchers, authors/experts and institutions cover a wide range of officials of various government departments, intergovernmental agencies, non-governmental organizations, voluntary organizations, etc. Full list of contributors, members of the editorial board, reviewers and participants of the training workshops appears in the Appendix. Special thanks are due to:

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Executive Summary

History of Dhaka stated in the 1st Millennium but did not rise to prominence until the 17th century when it served as Mughal capital of Bengal Province, from 1608 until 1639 and later again from 1660 until 1704. It was the centre of a flourishing sea trade, attracting English, French and Dutch traders.

With the removal of the provincial capital in 1704 to Murshidabad and the decline of the muslim industry, Dhaka entered a period of decline. It passed under British control in 1765, was constituted a municipality in 1864, but continued to decay until it was designated capital of Eastern Bengal and Assam province (1905-1912). During the early 20th century, Dhaka served as a commercial centre and seat of learning. In 1947, it became the capital of East Bengal province and in 1956 of East Pakistan. Dhaka suffered heavy damage during the war of independence in 1971, but emerged as the capital of Bangladesh.

Over the past decade Dhaka has had the highest population growth rate of any major city in the world. With more than 13 million inhabitants with an area of 1,353 km^2, it is now the 8th largest city of the world and by 2015 it is forecast to be the world's second largest with around 23 million people. At present Dhaka mega city comprises one city corporation and 5 municipalities. These are Dhaka City Corporation (DCC) and municipalities of Narayanganj, Kadamrasul, Savar, Tongi and Gazipur.

DCC is centrally located and have all major administrative offices and central business districts. The city is also surrounded by a river system comprising the Buriganga, Balu, Turag and Shitalakhya rivers. The physical growth of the city basically started from the current extreme south and advanced along the Buriganga River and then expanded towards the west (Hazaribagh) and the east (Gandaria) and later to the north (Mirpur).

Development of industries, commerce and business, housing and infrastructure is being occurred in the last few decades along with population growth. This growth has significantly expanded the city's physical boundary all around but not at the same scale. Core service providing agencies are facing difficulties to meet enormous demand of the growing population and sometime is going beyond their capacity. As a result, key components of the city environment both physical and social are greatly impacted and most of them are in a continuous trend of deterioration.

This State of Environment Report 2005 has analyzed nine key environmental issues using Integrated Environmental Assessment (IEA) methodology. These nine issues are a) air, b) water, c) land, d) noise, e) environmental health, f) solid waste management, g) sewage management, h) slums and squatters, and i) natural disasters.

The format of this state of the environment report has been adapted from the framework of writing state of environment reports for any city of the member countries of the Organization for Economic Cooperation and Development (OECD). The analysis identified 21 driving forces that have significant influence on the environment of Dhaka city. Of them, the major driving forces are:

- Unplanned urbanization
- Lack of enforcement of existing environment, traffic, industrial, and agricultural laws, policy and guidelines
- Excessive population growth
- Improper transport and traffic management
- Improper Solid Waste Management
- Poverty and migration
- Unplanned and rapid industrial development
- Lack of awareness
- Management constraints
- Lack of transparency and accountability
- Lack of effective coordination among core government agencies
- Inadequate and inefficient sewage management

Air quality of Dhaka city has improved substantially in the recent past due to the removal of two-stroke engine baby taxis. But the gains are being progressively lost due to pollution from diesel vehicles and urban construction. The main air quality problem in Dhaka is the high level of particulate matter. Both PM_{10} and $PM_{2.5}$ levels are high, being much above the safety standards especially during the dry season. The increasing number of vehicles and their improper management and operation are responsible for degradation of the air quality. The transportation sector is also largely responsible for noise pollution.

The economic valuation of the air pollution revealed that between US$ 121 to 353 million per year (2003 estimate) can be saved in Dhaka as health cost if the PM10 pollution level is reduced by a modest 20% of the current level and to the proposed national standard (Khaliquzzaman, 2005a).

The key measures for improving air quality of the city are a) introduction of Compressed Natural Gas (CNG) based vehicles, b) introduction of unleaded gasoline from 1st July of 1999, c) notification of lubricant standards on 1st January, 2001, d) banning of buses older than 20 years and trucks older than 25 years in Bangladesh from 2002, e) banning of two-stroke engine three wheeler vehicles from 1st January, 2003, f) banning of imported reconditioned cars older than 5 years, g) reduction of number of NMVs (Non-Motorized Vehicles) and by restriction of movement of such vehicles in certain areas of the city and during specific periods of the day and h) banning of operation of commercial trucks in Dhaka city during day time (8 am to 10 pm).

The industrial liquid waste and sewage disposal into the rivers not only pollute the surface water but also threaten the ground water resources through recharge. The rivers Buriganga, Balu, Turag and Shitalakshya together receive huge amount of untreated sewage and industrial liquid waste as well as municipal waste regularly through the three major canal systems and direct disposal. Water of the surrounding rivers and lakes has already exceeded the standard limits of many water quality parameters, for example, DO, BOD, COD, pH.

Demand for supply of water is also huge and WASA can supply water to only 55% to 60% of city people. The rest gets water from privately owned DTWs. The number of these privately owned DTWs in Dhaka city is 688. In fact, rapid real estate development, industrial establishment and informal settlements have created huge demand, which is met through legal and illegal water supply connections. According to the managing director of WASA, there are about 50,000 illegal connections in Dhaka (The Daily Star, January 25, 2004). It is reported that Mirpur and Postagola areas have maximum illegal connections. Many of the legal and illegal connections causing huge misuse of water and creates supply crisis.

The total supply of water by WASA is 1,376 MLDs, of which about 1,148 million liters drawn from groundwater source through 395 deep tube wells in Dhaka city. The rest of the water comes from Saidabad and Dhaka water treatment plants (WASA, 2004). The city gets about 81% of the total water from ground water sources (WASA, 2004). The demand for supply water has increased to 2000 million liters in 2003 from about 1345 million in 1998, when the number of deep tube wells of WASA was only 234 (Nishat and Others, 2000). This demand increases during summer, when the supply decreases.

Government should take initiative to reduce illegal connections and system loss, which is happening mainly due to lack of transparency and accountability, monitoring and professional sincerity.

Natural growth of population and huge migration every year due to many push and pull factors raised the growth rate to about 7 percent. This huge population growth has increased the basic demand for settlements and utility services and thus turn into establishment of both formal and informal settlements (slums and squatters).

In addition, most of the designated residential areas including Dhanmondi, Gulshan, Baridhara, Uttara, and Banani are also more or less occupied by excess number of schools, colleges, universities, coaching centers,

industries and factories particularly garments, health care centers (hospitals, clinics, diagnostic centers), mushrooming shopping malls and small-scale business enterprises. The first designated residential area, Dhanmondi, virtually a semi-commercial area now. The same situation is prevailing in the old city. It is very difficult now to identify whether the old city currently contains any residential area, though once major parts of it were high-class residential areas. The old city is now severely crowded and compacted with population and housing respectively.

Heavy rainfall of even small duration causes water logging in most of the areas of Dhaka city. This water logging is primarily due to inadequate storm water sewer infrastructure or absence of any sewer system at all. Furthermore, if there exists any storm sewer system, then it will be found less effective being partly or fully filled with sediment or will be found inadequate in size or laid in improper grade. All these causes make the system disabled to drain out the storm water in time. Covering the storm water inlets by road carpeting materials or other construction materials and improper maintenance of inlets of storm sewer aggravates the scale of this problem. Increase of concrete/metal surface day by day is also contributing in increasing the volume of surface runoff which is worsening the water logging phenomenon.

The government has taken a large number of initiatives to control the environment of the city but without strict enforcement overall environmental degradation can not be reversed . The development of systematic road transport system through introduction of by-cycle in the city with separate track, construction of bypass, link road and fly over or even under pass, based on proper study and investigation, may lessen transport congestion and therefore reduce air pollution.

Coordination of inter-governmental agencies is also required for the betterment of the environmental state of Dhaka city. Establishment of any further industrial units and brickfields must be discouraged within and around the city area.

To ensure water supply from ground and surface water sources, the government may need to stop unplanned residential and industrial development, concrete surface development and improve waste and sewage disposal system. Proper industrial waste and sewage treatment may protect water resources of the city.

The drainage system of the city needs to be improved through monitoring, rehabilitation and extension immediately. The government may increase the environment related budget, particularly for solid waste management of the city corporation. DCC should have sanitary landfill sites which may ensure reduction of air and soil pollution. Immediate implementation of the decision of relocation of the tanneries from Hazaribagh to Savar and the assurance of the remediation programme for tannery contaminated sites would be greatly appreciated.

The city also faces extreme noise hazards due to vehicular operation and movement, unnecessary use of loudspeakers, horns, high volume of audio music, and unauthorized metal hammering activities on the footpaths. These should be controlled immediately through enforcement of existing laws. Besides strict enforcement of the environmental laws, initiation of Occupational Health and Safety Rules or Policy may reduce disability, morbidity and mortality of the city laborers.

Natural disasters, particularly floods are another factor that often affects the city environment and human health. Floods reduce production in industrial and business operations, destroy road infrastructure, water supply and sanitation system, and cause water borne diseases. A permanent solution should be sought immediately through construction of embankments, improving drainage and sanitation management and increasing safe water availability.

Moreover, the Department of Environment (DoE) should be strengthened so that it can properly implement the policies and decisions already taken to make Dhaka city more livable and environment friendly.

1. Introduction

Dhaka, the capital and the most populated city of Bangladesh, is now a member of the "mega-city" family of the world. Dhaka, the fifth largest mega city, comprises Dhaka City Corporation (DCC) and five adjacent municipal areas i.e. Savar, Narayanganj, Gazipur, Kadamrasul and Tongi (Akash and Singha, 2003; BBS, 1991). The area of Dhaka mega city is 1,353 km^2 of which DCC occupies 276 km^2 (BBS, 2001). According to United Nation Population Fund (UNFPA) the total population of Dhaka mega city is now over 12.3 million of which population of DCC is about 8.4 million. According to Bangladesh Bureau of Statistics, population of Dhaka mega city and DCC is about 9.9 millions and 5.3 millions, respectively (BBS, 2001). The population density of DCC is 19,286 per km^2 which is more than double of the mega city average of 7,918 per km^2.

The city is situated between 23°42' and 23°54' north latitudes and 90°20' and 90°28' east longitudes. It is surrounded by the river Buriganga on the south, Turag on the west, Tongi khal on the north and Balu river on the east (Banglapedia, 2003). The geographical location and administrative units of the city is given in Figure 1.1. The city usually experiences characteristics of tropical monsoon climate with an annual average temperature of 25°C and 2000 mm of average annual rainfall (DOE and IUCN, 2000; Bangla, 2000).

There are a number of service providing organizations. Of them, the key organizations are Dhaka City Corporation (DCC), Dhaka Metropolitan Police (DMP), Dhaka Water and Sewerage Authority (DWASA), Dhaka Electric Supply Authority (DESA), Titas Gas Limited, Bangladesh Telephone and Telegraph Board (BTTB), Rajdhani Unnyan Kortripakhkha (RAJUK), Dhaka Electricity Supply Company (DESCO) and Department of Environment (DoE) serving city dwellers with specific utilities (Siddique *et al*., 2000). Apart from these, health, education, planning, housing, transportation and other infrastructure related organizations do exist in the city area.

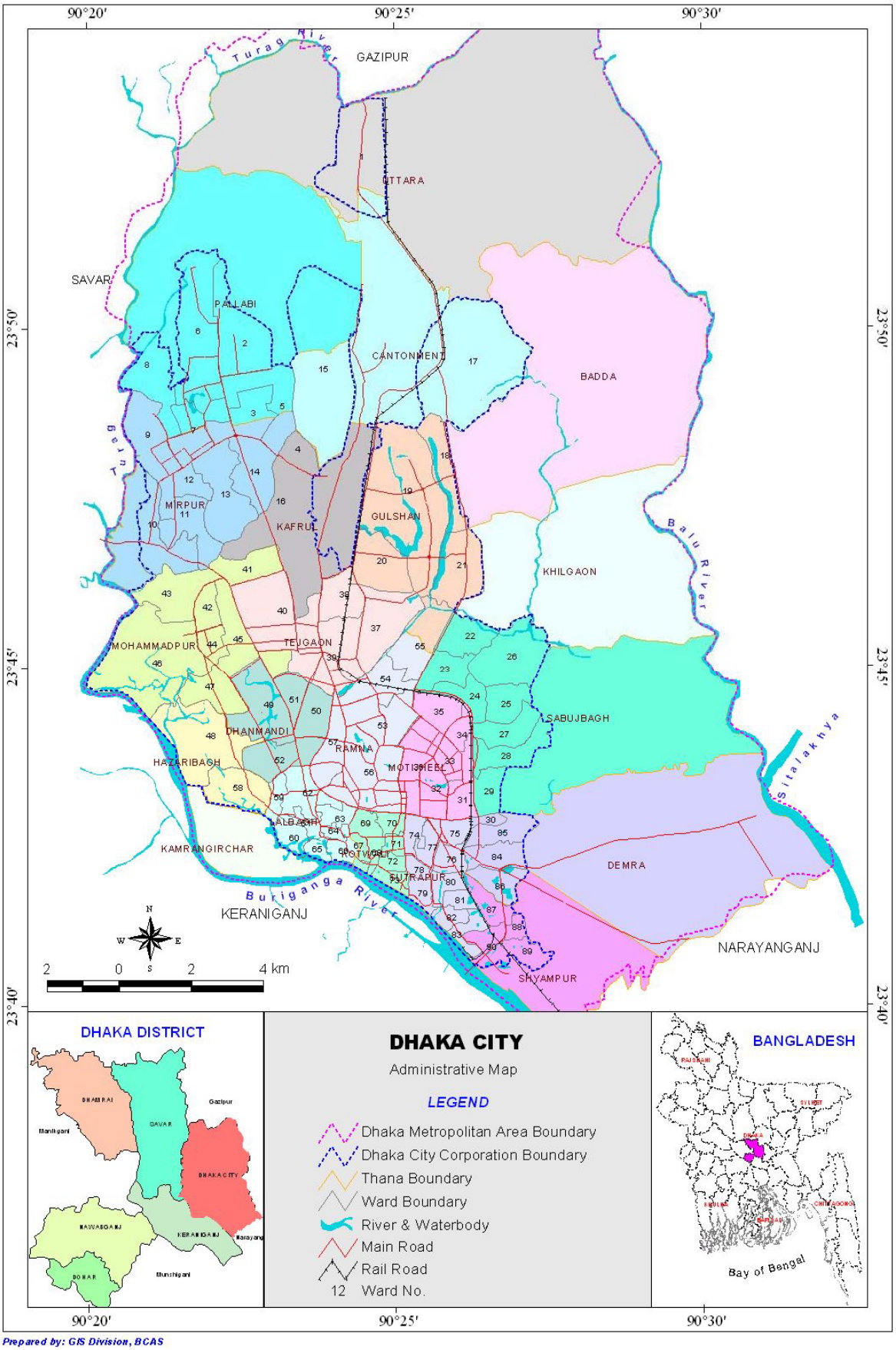
Area under jurisdiction of different authorities serving Dhaka also varies. Dhaka Metropolitan Area (DMA) is somewhat larger than the DCC, and currently holds 21 Police Stations. Dhaka Statistical Metropolitan Area (DSMA), which is considered as Dhaka Mega city. Rajdhani Unnayan Kartripakkha (RAJUK) has a Strategic Planning Zone-wise definition of Dhaka city which is known as Dhaka Metropolitan Development Plan (DMDP). It currently consists of total 26 zones of which 19 may cover Dhaka Statistical Metropolitan Area, though the total area is about 1528 km^2 (DMDP, 1997). Boundary of different authorities, and built up and low-lying areas of Dhaka city given in Figure 1.2a and 1.2b respectively. But it is true that most people think that Dhaka means the municipal corporation and few adjoining developed areas like Mirpur, Uttara, and Baridhara.

Dhaka was a city of 2.8 million in 1981, which rapidly increased to 5.3 million in 2001 while physical expansion of city area was negligible.

Historical sites and nature spots such as the Lalbagh Fort, Ahsan Manzil Museum, Bahadur Shah Park, Curzon Hall, Baldha Garden, Ramna Green, Suhrawardy Uddyan (Garden), National Park, Botanical Garden, Dhaka Zoo, Shaheed Minar, National Museum stand as witnesses to the legacy of Dhaka. Figure 1.3 depicts location of historical places of Dhaka city.

Most of the government and non-government regulatory and administrative headquarters are situated in Dhaka. The advantage of multi-way communication system with all districts, location of primary international business house, trade and commerce play as the primary pull factor.

Rapid and unplanned urbanization, commercial development, along with population pressure have made Dhaka an environmentally polluted city in the world. Concentration of suspended particulate matter, carbon monoxide, nitrogen oxides, sulpher oxides, etc. often exceed the safety standards of Bangladesh. The surrounding river systems have become badly polluted due to chemical and microbial contamination by the industries situated on the banks of the major rivers and untreated sewerage discharge from large part of the city. The groundwater level of the city is



Prepared by: GIS Division, BCAS

Figure - 1.1. Location and Administrative Units of Dhaka City

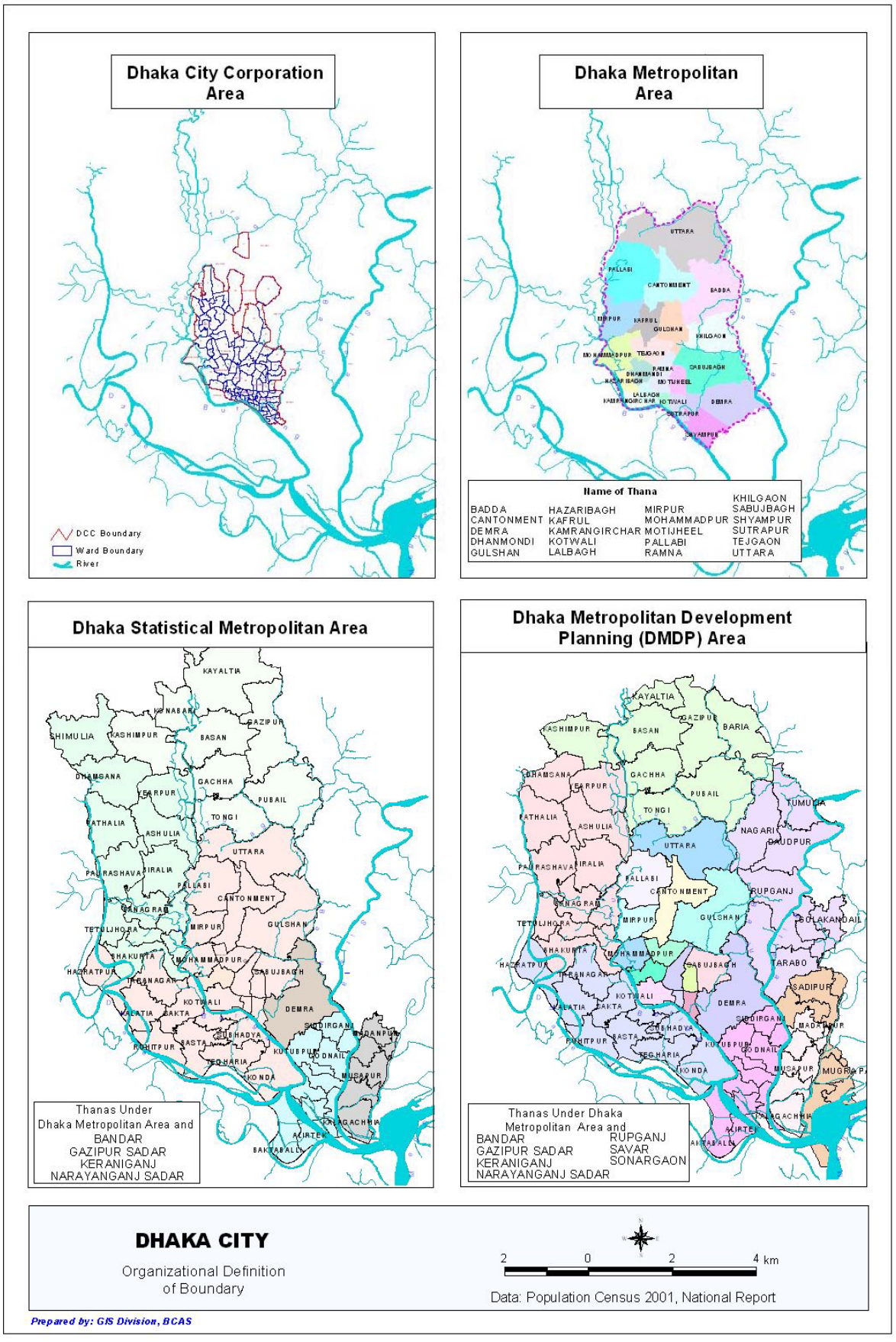


Figure - 1.2a. Area under Jurisdiction of Different Authorities

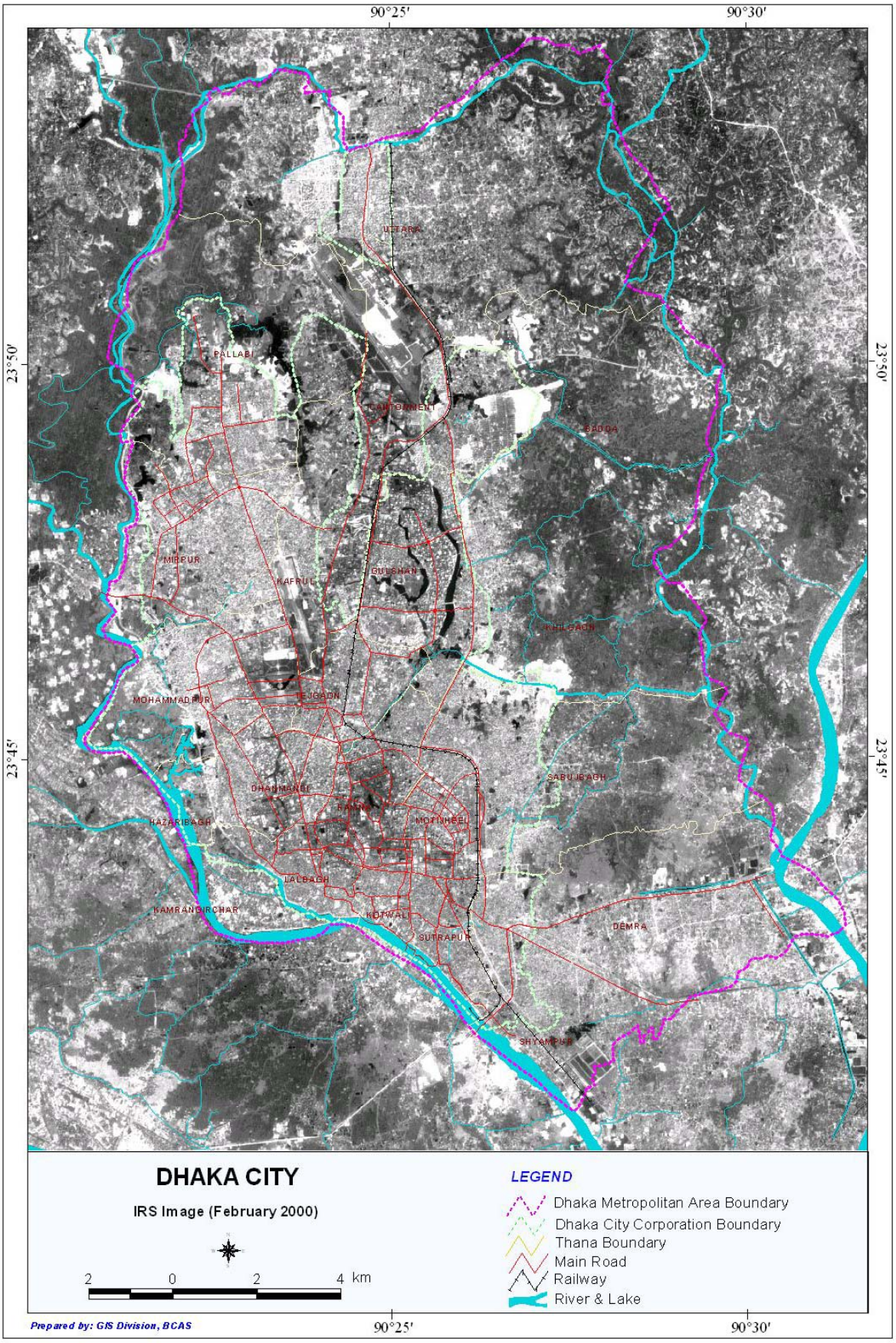


Figure - 1.2b. Built and Low-lying Area of Dhaka

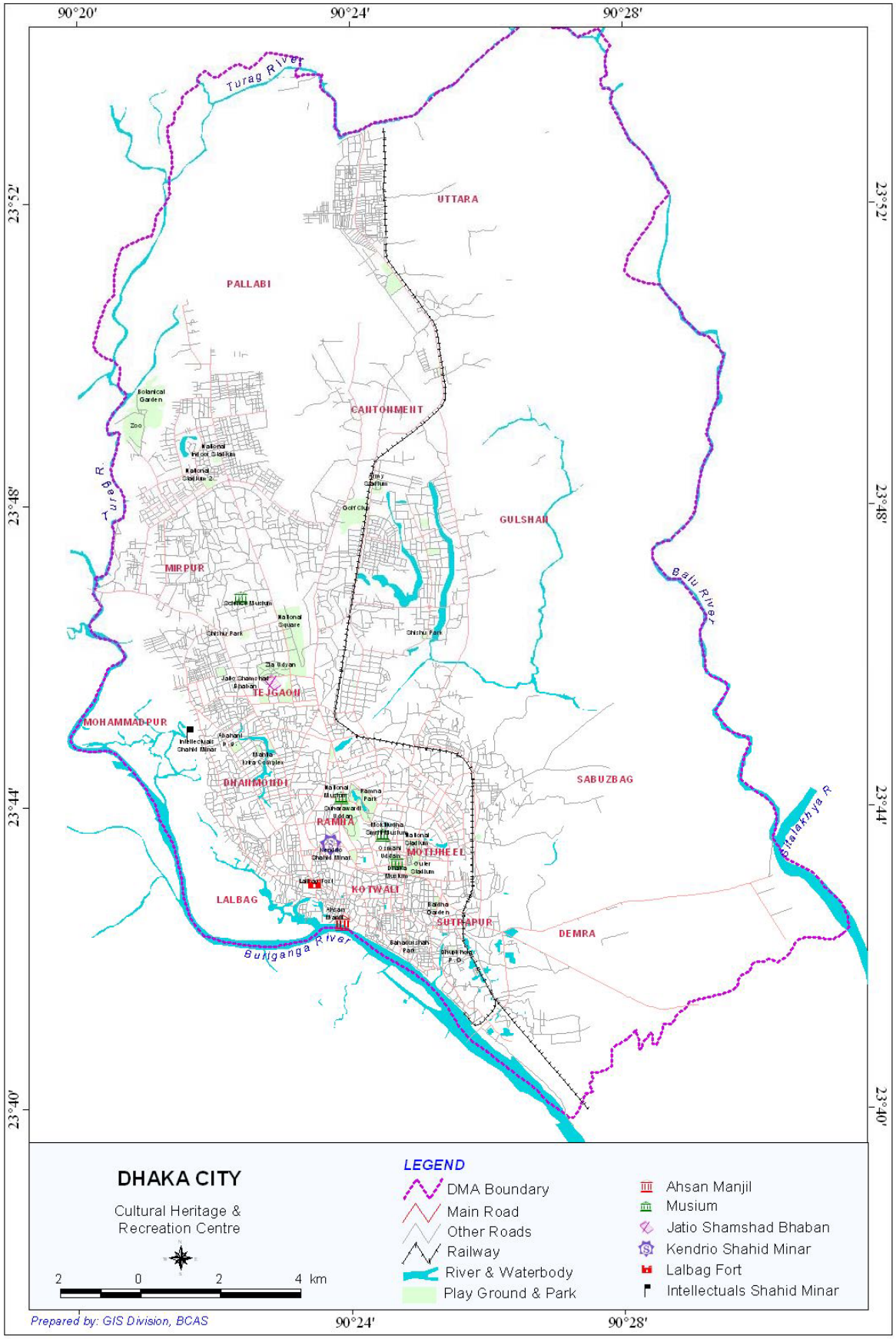


Figure - 1.3. Location of Historical Places of Dhaka City

also being affected with a fall of more than 0.75 meter per year (Hasan, 1996). Many areas of the city are already experiencing higher noise level. Increasing incidences of respiratory infections, asthma, cardiac problems, auditory difficulties, emphysema, pneumonia, diarrhea, and gastrointestinal problems, skin diseases etc. especially in children, testify to the environmental degradation of Dhaka city.

1.1 History of Dhaka City

Dhaka carries a very long history dating back from the 7th century A.D. to present times. The city actually faced a dramatic historical turn-up from its beginnings as a small city with few people, to the tremendously expanded demographic and topographic structure it is today with distinct spatial and demographic characteristics.

According to available literature and documents, the present city once started with only 1 square mile area and then extended to 2 square mile in the 16th century with a population of over 3 thousand (Asaduzzam & Rob, 1997 in DCC, 2004). From the 16th century till 1981, the total population increased from 3 thousand to over 2.8 million, with the area extended to 208 km^2 (BBS, 2001). Historically, the development of Dhaka city started from the southern part, that is, the present "old town" (Pre-Mughal period), then the extension continued toward the west and the north (Mughal and British period). During Pakistan period, the development advanced primarily towards the north and it continued rapidly and in an unplanned way towards every side of the city. Figure 1.4 shows changing pattern of Dhaka City and its population and the following section provides a brief on city's physical development at different stages of its growth.

1.1.1 Pre-Mughal Period (before 1608)

The history of the present Dhaka city before the 16th century is obscure, but the available documents represent that some parts of the greater Dhaka was ruled by the Buddhist then the Hindus till around the 13th century. However, Muslims arrived to colonize Dhaka and the nearby areas after 1275. The Turks and the Pathans ruled Dhaka till the arrival of the Mughals (Islam, 1999). At that time, present Dhaka city had an area of only 2 km^2 with a small population as mentioned earlier.

In the Mughal period, Dhaka was called the "City of 52 bazaars and 53 lanes".

1.1.2 Mughal Period (1608-1764)

The Mughals came to Dhaka in 1606 when Qutubuddin Kokah and Jahangir Kuli Khan were temporary governors under Emperor Jahangir, keeping their headquarters at Akbarnagar (Rajmahal). In 1608, Sheikh Alauddin was permanently appointed as governor of the province with the title of Islam Khan (Bangladesh District Gazetteers, Dacca [Dhaka], 1975). Islam Khan made Dhaka the permanent capital of the province and renamed it as Jahangir Nagar. Road communication from Chawk Bazar to Babu Bazar, and the expansion of the present "old town" to Sadar Ghat were done by Islam Khan from 1606 until his death in 1613. He also constructed a canal beside Tantibazar and Malitola to connect the Buriganga and Dolai khal (BDG, 1993).

After Islam Khan, Ibrahim Khan (1617-1624) took over and built Dhaka as a prime centre of business and trade in South Asia. The Europeans (Portuguese, Dutch, English, French, Armenians and Greeks) took advantage of this opportunity for trade but unfortunately, it did not last due to shifting the capital from Dhaka (Jahangirnagar) to Rajmahal by Shah Shuza (1639-60) in 1640, though Mir Jumla (1660-63) relocated the capital from Rajmahal to Dhaka again. Mir Jumla was well known for his development activities of Dhaka city--the Tongi-Jamalpur and Dhaka-Fatulla connecting roads were constructed during his period (Alam and Huq, 2002).

However, most of the development and settlement of the city took place during the Mughal period (1608-1764). During his reign, the construction of a road from the Buriganga to Tongi (South-North, 22 km) and Dolaikhal to Babupura (East-West) and set up many industries and factories took place (GOB, 1993). Dhaka was then called the "City of 52 *bazaars* (markets) and 53 lanes". In

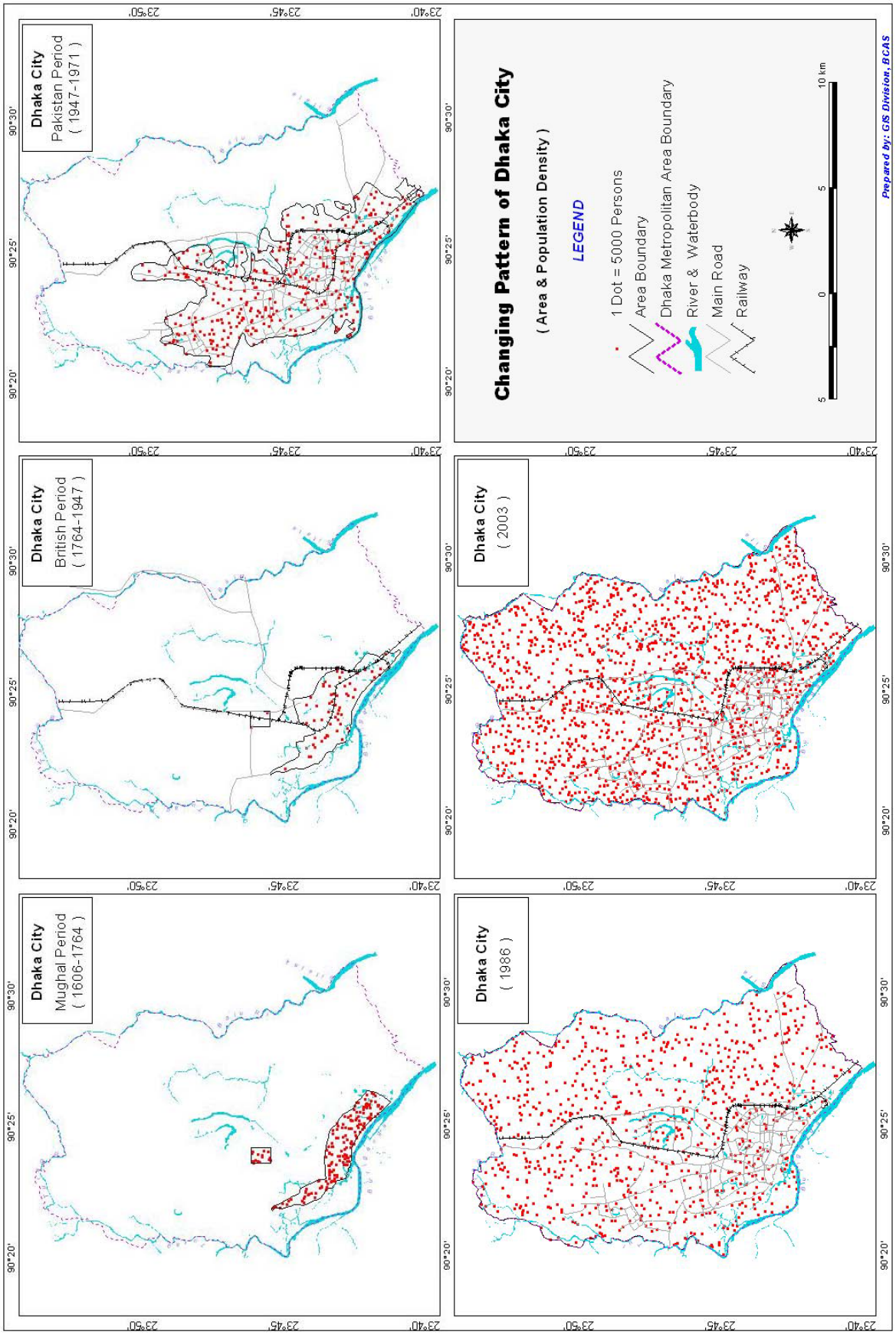


Figure - 1.4. Changing Pattern of Dhaka City and Its Population

comparison with commercial and industrial development in the Mughal period, road communication development was lagging behind. However, in 1717 the capital was again shifted from Dhaka to Rajamahal (Murshidabad), which resulted in a serious declination of demographic and urban structure of Dhaka city (Mamun, 1994). The population of Dhaka city in the Mughal period was 0.9 million living within its 50 km^2 area (DCC, 2004).

1.1.3 British Period (1764-1947)

At the beginning of the British period Dhaka experienced famines, floods, disease epidemics and loss of trade and business etc. that resulted in dramatic decrease in population. The population of Dhaka fell to 0.2 million and the area to 8 km^2 in the 18^{th} century due to the adverse situation (DCC, 2004). However, both population and area of Dhaka recovered and started to expand again with housing, transport, utility services and especially due to development of health and educational facilities. The noticeable development in the educational sector included establishment of Dhaka College in 1835, Jagannath College in 1858, Eden College in 1880, Teachers' Training College in 1909, and the Dhaka University in 1921 (Mamun, 1994).

The people of Dhaka started using piped water supply and electricity in 1874 and 1878 respectively, which caused a great change in lifestyle of the city's people. The Dhaka Municipality was established in 1864, when the development of the city advanced from the east to the eastern fringes of Gandaria and towards the west up to Nawabganj. Also, this period saw many changes and rearrangement in the residential patterns and development in Wari, Ramna and Purana Palton areas. Development of railway communication and road transport were also remarkable. Government administrative control was updated, forming two units located at Ramna and near Victoria Park. Then the declaration of capital in 1905 changed the population figure of Dhaka, though it lost administrative control again in 1911. However, the population of Dhaka at the end of British period was nearly 0.3 million within 64.7 km^2 of area (DCC, 2004).

1.1.4 Pakistan Period (1947-1971)

After partition of India in 1947, Dhaka was made the capital of the province of East Pakistan. The new capital then had to face tense situations like communal riots and political crisis over the state language issue that resulted in a substantial decrease of population growth of Dhaka in 1951. However, the rapid development of housing, factory/industry, business and government offices took place in Mohammedpur, Mirpur, Tejagaon, Ramna, Purana Palton, Segun Bagicha and some other adjoining areas during this period. Some of these areas were expanded during this period and many were recognized by Dhaka Improvement Trust (DIT) for development after 1956.

The Dhaka Improvement Trust (DIT) was transformed into Rajdhani Unnayan Kortripakhkha in 1987 (Alam and Huq, 2003). The DIT showed a significant success in the development of Gulshan, Banani, Uttara and Baridhara Model Towns, and in improving the road transport system of Dhaka city. However, most of these model towns became congested due to new housing, commercial development and mixed land use practices. Dhaka actually faced many challenges during the Pakistan period, mostly in the early years, though it neither seriously affected its population growth nor development of different sectors, for example, housing, industry/factory and infrastructure. In 1974, the city population was over 2 millions.

1.1.5 Bangladesh Period (1971-Onward)

Dhaka rearranged itself again as the capital city of Bangladesh after the liberation war in 1971. It accommodates all public and private factories and industries, and commercial establishments. The significant influx and natural growth of population after liberation war made this one of the most populated cities in the world.

In the recent year, the model towns of

Dhanmondi, Uttara, Gulshan, Banani and Baridhara became congested due to mixed and semi-planned development practices. Informal settlements (slums and squatters) were established in the central part of Dhaka. Nearly one–third of the total population of Dhaka basically reside in slum areas and support the city with cheap labour like rickshaw pulling, construction activities, working in workshops and factories, small business and trade, hawking and as household domestic help. Figure 1.5 shows the historical development and growth of Dhaka.

Most of the utility services were expanded or newly developed to support the vast number of city dwellers in last few decades. However, the core authorities of the city are still unable to fulfill the basic requirements like water supply and sanitation, solid waste management, power supply etc. Health and education sectors were also quite developed compared to other periods through the initiatives of both the government and non-government organizations. However, the quality of these services may be questionable.

The major problem faced by Dhaka now is due to unplanned development. The city has lost its capacity provide quality living standard to the city dwellers especially in terms of environmental and health requirements. Dhaka was a city of 2.8 million in 1981, which rapidly increased to 5.3 million in 2001 while expansion of city area was negligible i.e. area increased to 276 km^2 from 208 km^2 in the same period.

1.2 Culture, Heritage and Beautification

Dhaka City has quite a few wonderful attractions and outstanding historical places such as the Lalbagh Fort, Ahsan Manzil Museum, Bahadur Shah Park, Curzon Hall, Baldha Garden, Ramna Green, Suhrawardy Uddyan, Botanical Garden, Dhaka Zoo, National Museum and several mosques, lakes and water bodies. These are not only recreational sites, but most of these stand as evidence of the bygone days and colorful history of Dhaka city, and Bangladesh as well.

Photo - 1.1. People Celebrating Pahela Baishak (Bengali New Year)

The city has a wide reputation on the practices of cultural activities. People enjoy the celebration of cultural events such as the Pahela Baishak Carnival (Bengali New Year), Ekushey February (21 February), now observed as World Mother Language Day, open-air poetry sessions, street plays, musical performances, and numerous book fairs. Religious gatherings are also mentionable particularly Eid festival, Durga Puja, Bishya Ejtema, Christmas day.

Dhaka City was once known for its serenity, beautiful parks, clean roads and lush greenery, but the present condition is one of overcrowding, traffic congestion, excessive noise and dirt. The past twenty years have seen an explosion of growth and expansion in Dhaka city due to rural–urban migration, combined with unplanned city development, lack of adequate roads for the increased traffic and congestion caused by numerous high-rise buildings. Another issue of contention is the presence of huge billboards on every street corner and decorating the face of buildings, parks, sidewalks.

The programme “Beautification of Dhaka City” was launched in 2004 ahead of the proposed SAARC Summit of 2005 (Photo 1.2 - 1.4). This beautification work has been carried out under the Prime Minister’s Office with the help of the Dhaka City Corporation (DCC). The government has enlisted the services of 54 private and 17 public organizations to carry out works of

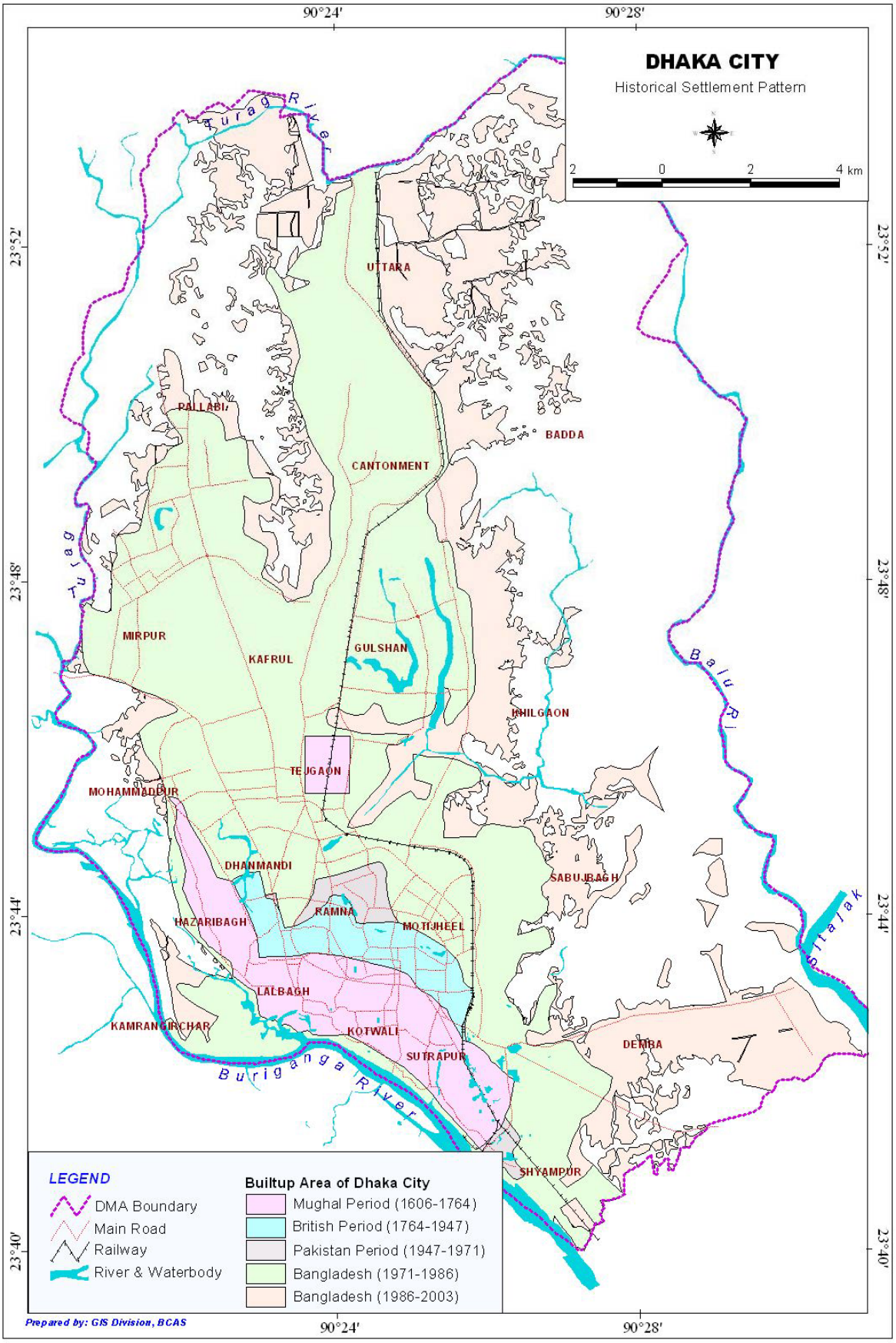


Figure - 1.5. Historical Growth and Development of Dhaka City

beautification in various areas of the city. These 71 organizations and institutions have been allotted 105 different sections of roads and street intersections for beautification and maintenance of these activities until March 2008 (The New Nation, 2004). The organizations are undertaking the beautification work at their own costs without any financial assistance from DCC.

Also in accordance to the theme of the World Environment Day 2005 "Green Cities-Plan for the Planet!" the government has taken the initiative for the beautification and greening of Dhaka city through tree and flower plantation. The Dhaka Urban Transport Project (DUTP) and Dhaka Transport Coordination Board (DTCB), with the support of different organizations, have been given the responsibility to make the city roads beautiful (DOE, 2005). Results of their efforts can be seen along the Airport Road, Sangsad Bhaban and various important intersections and parks.

Beside plantation of trees and flowering shrubs, water fountains and sculptures have been constructed at various intersections/ roads of the city, for instance, at Farmgate, on Airport Road, Bijoy Sarani, Zia Uddan etc. Unpaved parts of roads, footpaths and medians were used for the plantation of decorative plants and shrubs. Also waste bins have been provided at almost every street corner to discourage the pedestrians from littering. So far, the beautification drive has made a positive impact on the people of Dhaka but there is skepticism regarding the long-term maintenance of these beautification activities.

Photo - 1.2. Landscaping along the Airport Road

Other activities have also been undertaken for the betterment of the city and the city dwellers. Computerized/synchronized traffic signals have been placed all over Dhaka City to streamline and facilitate smooth movement of traffic. Also roads have been set aside for

Photo - 1.3 : Decorative Landscape and water fountain on Manik Miah Avenue, Dhaka

Photo - 1.4. Fountain at Hotel Sonargaon intersection in Panthapath

non-motorized vehicles in order to minimize congestion.

The living conditions in Dhaka city has improved considerably despite the high density of people. Both private and government organizations have to be given credit for their role in the beautification of the city. The past year has heralded a new look for Dhaka city which is now more aesthetically agreeable and environmentally sound. More efforts, activities and basic awareness programs can convert Dhaka from an urban jungle to a garden city once again.

1.3 Evolution of State of the Environment Report

In 1969, the United States of America initiated reporting on the state of the environment (GEO, 2002). This initiative was broadly adopted as a global programme of action at the Stockholm Conference on the Human Environment in 1972. Initially, the state of environment reporting was on biophysical environment e.g. land, freshwater, wildlife etc. But over the years, the process has been developed in an integrated manner to highlight interactions between human and environment. A framework (PSR-pressure-state-response) had been developed in the early days and later, it has also been updated to a new format (DPSIR-driving forces-pressure-state-impact-response) to connect the causes (diving forces and pressures) to environmental consequences (state) to actions (policies and decisions). In 1999, the United Nations Environment Programme (UNEP) has initiated the preparation of national and regional level state of environment report.

The Government of Bangladesh in collaboration with Bangladesh Centre for Advanced Studies (BCAS), the South Asian Cooperative Environment Programme (SACEP), United Nations Environment Programme (UNEP) and Norwegian Agency for Development and Cooperation (NORAD) prepared the Bangladesh State of Environment Report in 2001. A number of environmental issues have been identified as points of national concern. The report has emphasized the deterioration of urban environmental quality particularly Dhaka among other cities of Bangladesh. As a follow up activity of Bangladesh State of Environment Report: 2001, Dhaka city has been considered for detailing its situation using Integrated Environmental Assessment (IEA) framework and reporting with the title of "Dhaka City State of Environment Report: 2005".

1.3.1 Background and Objective

The updated information on the environmental condition is important in the decision-making process for sustainable development. The collection and assessment of this information on a regular basis is also essential. In order to assess and evaluate the issues related to environment, there is an absolute need for a strong information base on all aspects of natural resources and ecosystem, which are to be systematically collected from decentralized multi-sectoral environmental agencies/ institutions, analyzed, and presented in a timely manner.

This initiative of preparing Dhaka City State of Environment Report: 2005 is a component of a global programme on building capacities undertaken by the Division of Early Warning and Assessment (DEWA) at UNEP. It will provide a mechanism to transfer the experience and knowledge gained by UNEP through the global GEO process to regional, sub-regional, national, local governments and organizations in developing countries involved in assessment and reporting. By facilitating more widespread adoption of the GEO approach, the project will also increase the compatibility of reporting and assessment processes and products.

The aim of this initiative was to provide capacity building on integrated environmental assessment using specially developed training tools for preparation of the City State of the Environment (SoE) report. The project strengthen the capacity of different government and non-government agencies through provided training and establishing a network. This helped information sharing, data processing, modeling and analysis requirements that supported assessment and

preparation of State of the Environment (SoE) Report. The ultimate aim was to improve the basis for decision making in the handling of important/emerging environment problems towards sustainable development.

1.3.2 Methodology

Dhaka, the capital city of Bangladesh was selected for assessing exiting environmental condition and preparing the State of Environment for assisting informed decision making. Department of Environment, Ministry of Environment and Forest commissioned Bangladesh Centre for Advanced Studies, a leading research organization of Bangladesh, as Collaborating Centre of UNEP to prepare the report with financial support from UNEP.RRC.AP.

International Institute for Sustainable Development (IISD) and the United Nations Environment Programme (UNEP) in collaboration with Ecologistics International Ltd has referred to two models for preparing Integrated Environmental Assessment and State of Environment Reporting. There were nine key environmental priority issues identified for preparing Dhaka City State of Environment Report: 2005. The assessment of these issues was done following both the following models:

i. **Questioning model** (Figure 1.6): There are four consecutive questions to be answered to prepare the state of environment report with an integrated assessment manner.

ii. **Flow chart model** (Figure 1.7): This model has been referred to as possible ideal process for preparing state of environment report. It includes a number of stages from planning and conceptual development to product dissemination.

1.4 Structure of the Report

The Dhaka City State of Environment report has been prepared based on the above methodology and format, and is composed of four sections with a number of sub-sections. The sections of the report are as follows:

What is happening to the environment?

Why is it happening?

What can we do and what are we doing about it?

What will happen if we don't act now?

Figure - 1.6. Steps in the integrated environmental reporting process (Printer et al., 2000)

Chapter One: This chapter presents an overview of past and present Dhaka city with historical growth. It also presents summary of the methodology and structure of the report.

Chapter Two: Chapter two provides an overview of major environmental resources and socio-economic condition of Dhaka city. This chapter highlights the trend and development in different sectors related to the city environment. The existing environmental management and legislative overview is also included in this chapter.

Chapter Three: This chapter includes the key environmental issues and their in-depth description highlighting the driving forces of the problems, impacts and responses of the relevant authority and society to the environmental condition. This chapter indicates the major gaps and offers options for better management and improvement of environment.

Chapter Four: Conclusion and recommendations provide possible immediate actions in the arenas of policy, research, and action to combat the situation towards sustainable environmental management and development.

Appendices: In addition to the above-mentioned chapters, there are five appendices in this report. Appendix-1 provides acronyms and abbreviations; appendix-2 provides the list of the major sources of data (organization/ reports/writer etc.); appendix-3 provides list of participants attended in the IEA/SOE training workshop; appendix-4 provides list of participants attended in the national consultation on draft state of environment report; and appendix-5 provides list of professional reviewers; appendix-6 provides list of editors of the report.

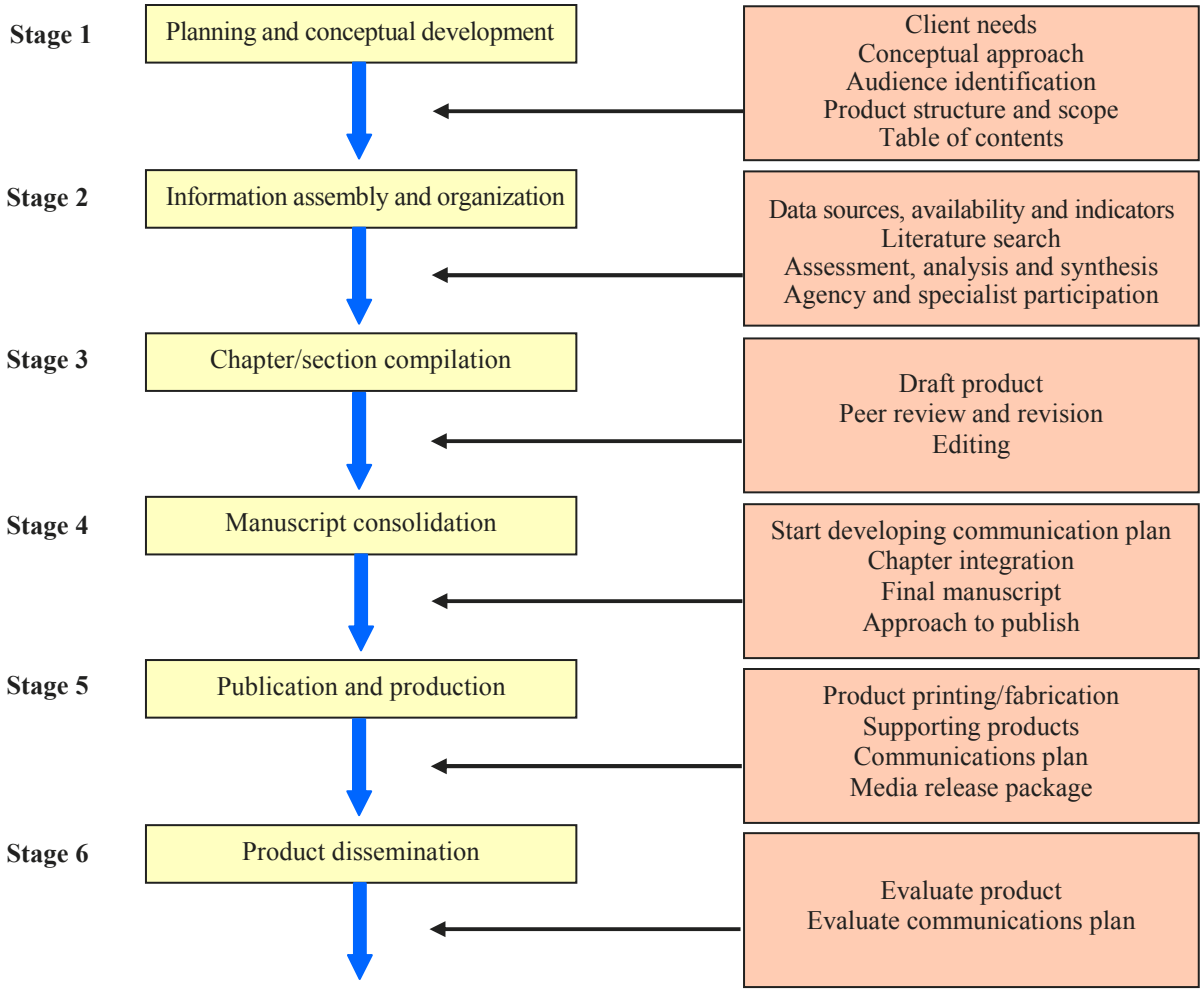


Figure - 1.7. Flow Chart of Different Stage of Methodology

1.5 Limitations of the Report

This report has been prepared based on secondary data and information collected from relevant organizations and published reports. Some of the key environmental issues were only supported with updated data. On the other hand, many of the relevant organizations and reports show the different figure of the same data for the same period e.g. solid waste generation, population etc. Therefore, some of the data are incorporated based on assumption. These may lead to certain limitations in the report. The following may be the limitations of the report:

- Different organizations show the different figures for the same issues for the same period.
- Sufficient updated data are not available for all priority issues.
- The data that have been used in this report from different sources may have some inaccuracies. For example, data on air quality of Dhaka city is used from the record of Continuous Air Monitoring Station (CAMS) of Air Quality Management Project (AQMP) but this station may not have covered the whole city. Some of the data have been used from the internet sources (website), which may not be very reliable.
- Though the report is entitled for 2005, some of the data of the priority issues have been used on availability. For example, the air and water issues of this report represent the data of 2005. Photographic documentation also indicates recent record on different issues.
- The issues were prioritized based rather on perception of relevant experts than on any scientific method.

2. Environment and Social Situation

This section on environmental and social situation provides an overview of key environmental resources, social situation including poverty, health and nutrition, status and stresses on service providing sectors, and institutional capacity and compliance to environment rules and regulations.

2.1 Key Environmental Resources

2.1.1 Land

Historically, the use of land for development of city started from the present old town and along the bank of Buriganga River. Later it expanded towards the north, and the flow of expansion was more or less continued in most of the regime though the remarkable growth was observed after the independence. The spatial distribution of land use distribution of Dhaka city is shown in Figure 2.1.

Dhaka City Corporation (DCC), central nerve of the Dhaka Mega City, presently covers more than 25 percent of the total land area of mega city. The elevation of DCC area varies from 2 to 13 meters above the mean sea level (msl) while the most of the developed areas are at an elevation of 6 to 8 meters above the msl. The land area above 8 meters msl covers about 20 km^2. The land ranging from 6 to 8 meters msl covers 75 km^2 while 170 km^2 of Dhaka is below 6 meters (JICA, 1987 in Alam and Huq, 2003).

Land area under different categories of use vary by sources. In 1991, out of 265 km^2 of land area of the city agriculture occupied about 45% of land area while residential and water bodies occupied about 19% and 14% respectively (JICA and GOB, 1991 in Siddiqui *et al.,* 2000). Before 1991, the figures were 46.8, 25.32 and 9.94% respectively within DCC area of about 208 km^2 (Ministry of land, 1982 and Dhaka Collectorate, 1989 in Human Settlement UNESCAP, 2004; BBS, 1991).

In fact, after the liberation war, the physical feature of the main city has been changed and covered by rapid development both by the government and private sectors. These include development of commercial, industrial, educational, health, communication and residential sectors.

Box 2.1: Parks and Open Spaces

There are about 50 parks and open spaces in Dhaka city of which DCC owns 46 (New Age Metro, August 2, 2003). Some of the parks have been occupied by encroachers who have set up temporary markets, bus stops, slums etc in these places. Of the total land area the city has only an average of 14.5% open space (17% in north and central part and 12% in old town) left whereas any city requires 25% for fresh environment and to maintain a sustainable land ecosystem.
Source: The Daily Star, April 12, 2004

Presently, the city development including all the above sectors covers approximately 40 km from north to south and 14 km from the east to the west (DCC, 2004). Many areas of the eastern part of the city, being low lying, support agricultural practices, which ultimately meet a major part of the regular vegetables demand of the city dwellers. Table 2.1 shows

Table 2.1. Land use distribution of Dhaka city at different times based on total area

Types of Land Use	Percent of **208** km^2 before 1991 (UNESCAP, 2004)	Percent of **275** km^2* After 1991 (Nishat and others, 2000)
Agriculture	46.8	46
Residential	25.32	22
Water Bodies	9.94	13
Industrial	2.49	1
Commercial	3.96	2
Institutional	1.63	4
Roads	--	6
Vacant land	3.09	--
Others	6.77	6

Source: (JICA, 1992 in Nishat and Others, 2000 and GOB, 1989 in UNESCAP, 2004)

* Area of Dhaka city is 275 km^2 (Nishat and others, 2000) while figure is 265 km^2 in Siddique and others.

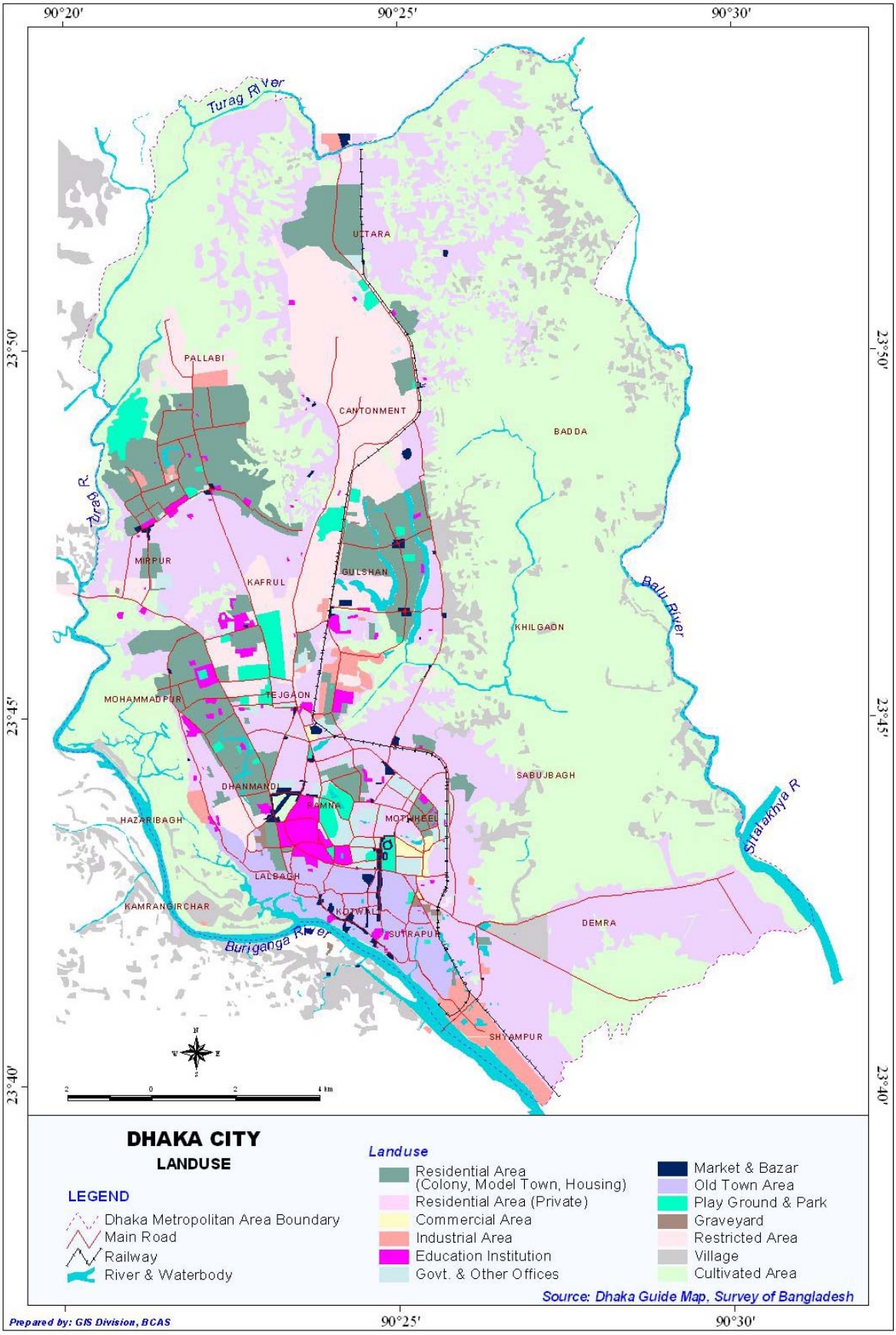


Figure - 2.1 General Land Use Map of Dhaka City

the land use distribution of Dhaka city before and after 1991.

Most of the government and non-government administrative headquarters, centres to control regional, national and international business and trade, industries, housing have been formally and informally established within the DCC area.

2.1.2 Air

Air quality of Dhaka city has deplorably deteriorated during the last few years, though the situation has partially improved due to a few interventions. The air quality of Dhaka is still deteriorating due to such activities as growth of settlements, brick fields, motor vehicles etc. The old part of Dhaka is severely congested and crowded with industrial and commercial units and old and new residential buildings. Many industrial units are located in Hazaribagh tannery area to the eastern fringe of Gandaria and along the Buriganga River. Lack of sanitation and proper waste management facility result in regular emissions into the ambient air that reduce air quality of the area.

Tejgaon and Mahakhali industrial area have the same problem with additional points of emission sources. Besides the industries, light motor vehicles, many heavy vehicles including buses, trucks, lorries etc. constantly run through the only internal road from the south to the north touching Maghbazar-Farmgate-Tejgaon-Mahakhali that cause the increase of air pollutants. However, the north-eastern part (Cantonment-Gulshan-Baridhara) of Dhaka is

Table 2.2 Air quality of central part of Dhaka city

Criteria Pollutants	Oct-02	Nov-02	Dec-02	Jan-03	Feb-03	Mar-03	Apr-03	May-03
SO_2 (Sulfur dioxide): monthly 24-hour average	4.3	8.5	19.5	19.3	24.0	15.5	6.2	1.6
NOx (Nitrogen oxide): monthly 24-hour average	DNA	134.9	107.0	121.3	89.3	63.3	23.3	20.0
CO (Carbon monoxide): monthly 1-hour average	1.5	1.6	DNA	2.5	1.6	1.1	0.4	0.5
O_3 (Ozone): monthly 1-hour average	16.0	19.0	22.9	28.9	57.4	57.9	29.9	20.1
Suspended particulate matter (SPM) PM_{10}: monthly 24-hour average	131.0	161.0	252.0	271.0	244.0	202.0	104.0	97.0
Suspended particulate matter (SPM) $PM_{2.5}$: monthly 24-hour average	90.0	138.0	192.0	196.0	151.0	88.0	46.0	36.0

Continued.....

Criteria Pollutants	Jun-03	July-03	Aug-03	Sep-03	Oct-03	Nov-03	Dec-03	Jan-04
SO_2 (Sulfur dioxide) :monthly 24-hour average	0.5	0.5	0.7	0.3	0.5	3.4	7.5	5.6
NOx (Nitrogen oxide): monthly 24-hour average	13.9	13.3	19.5	30.2	49.3	141.3	127.6	94.8
CO (Carbon monoxide): monthly 1-hour average	0.3	0.2	0.3	0.6	1.0	2.0	1.8	1.4
O_3 (Ozone): monthly 1-hour average	DNA	DNA	DNA	DNA	DNA	38.1	27.6	29.7
Suspended particulate matter (SPM) PM_{10}: monthly 24-hour average	68.0	46.0	50.0	65.0	93.0	183.0	168.0	192.0
Suspended particulate matter (SPM) $PM_{2.5}$: monthly 24-hour average	27.0	19.0	23.0	35.0	59.0	117.0	108.0	130.0

Source: Air Quality Management Project (AQMP), Department of Environment, 2004

Note: PM_{10}, PM_{2-5} concentration in micrograms per cubic meter
NO_X, O_3, SO_2 concentration in ppb CO concentration in ppm
DNA: Data Not Available

literally better than other areas in terms of air quality. This may be due to lack of overcrowding of population and residences, better utility service and traffic management, sufficient open space etc. In terms of seasonal variation, Dhaka enjoys better outdoor air quality excluding the presence of suspended particulate matter in monsoon season. In dry season, both outdoor and indoor air quality of whole Dhaka still pose risks to human health. Many studies have been carried out at different times to represent the contemporary air quality (out door and indoor) of the main city, of which samples are given in Table 2.2.

However, the outdoor and indoor air of Dhaka city is still getting polluted with increased SPM all the year around from different source of activities. These include construction and reconstruction of roads and highways, residential and commercial buildings, brick kilns, biomass burning for domestic and commercial purposes, especially in informal settlements (slums and squatters) and food making process of mushrooming eateries and restaurants, top soil erosion from agricultural and development works etc. Table 2.3 to 2.5 show the SPM concentration of outdoor and indoor air of different area of Dhaka city:

It is to be mentioned here that the condition of carbon monoxide and lead in the air is much better now due to the recent government actions i.e. banning of two-stroke three wheeler vehicles in 2003, banning of buses older than 20 years and trucks older than 25 years in 2002, introducing unleaded gasoline (1999) and Compressed Natural Gas (CNG) using vehicles etc. It should also be noted that the emission of volatile organic compounds may be significant in Dhaka city due to the availability of sources like open municipal dumping ground and motor vehicles which would react with oxides of nitrogen and form Ozone at the ground level.

Table 2.3 SPM concentration in the ambient air in different areas of Dhaka city at different years using high volume samplers

Year	Farm gate Police box	Gulshan police Box	Tejgaon	Mirpur	Gabtoli
1995-1996	727.8-1773.3	402.93-502.58	566.13-721.5	916.5-1599.6	497.11-998.75
1996-1997	424.06-2253.9	402.93-502.58	424.06-686.6	DNA	490.37-998.75

Source: Bangladesh Compendium of Environmental Statistics (BCES), 1997

Table 2.4 SPM concentration in the ambient air in different areas of Dhaka city at different years using high volume samplers

Date	Farm gate Police box	Agargaon	Tejgaon	Fire Service (Mirpur Road)
1998	397.65-2785.42	105.90-2485.3	497.1-535.7	180.7-751.9
1999	875.6.53.9	402.93-502.58	424.06-686.6	DNA

Source: Bangladesh Compendium of Environmental Statistics, 1997

Table 2.5 SPM concentration in the indoor air in different slums of Dhaka city at different times (2003)

Location	Dilu Road Slum SPM (mg/m^3)	Rayer Bazar Slum SPM (mg/m^3)
Kitchen	5092	4445
Kitchen	4545	10910
Kitchen	5253	4440
Kitchen	4040	18586

Source: WHO, 2002

2.1.3 Water

The surface water area of Dhaka city is about 10-15% of the total land area. This includes four rivers, four major canals, four lakes and many small ponds. Dhaka is primarily surrounded by three rivers, the Buriganga on the south-west, the Turag on the north-west and the Balu on the north-east. The Shitalakhya river flowing by the south-east part of greater Dhaka is also included surrounding river system and significantly contributes to supply water through which Saidabad water treatment plant produces average 170 MLD in July, 2003 to October, 2003 (WASA, 2003).

There are more than 40 canals within the city area that could have remarkable contribution in drainage service. The whole system is not functioning properly due to encroachment of these canals and improper management and overload of sewage. However, all the canals flowing through different areas and finally join the river system i.e. Segunbagicha–Jirani–Dholai khal joins with the Balu and Buriganga, Ibrahimpur–Kallyanpur khal joins with the Turag, Dhanmondi–Gulshan–Banani–Mahakhali–Begunbari khal joins the Balu river. The major lakes are Dhanmondi, Gulshan, Ramna and Crescent. The length and catchment area of major canals and lakes of Dhaka city are shown in Tables 2.6, 2.7 and Figure 2.2 is showing their location.

The lakes and small ponds that are found scattered in different areas of the city support the informal settlement (slums and squatters) for the dwellers domestic purposes, especially for washing and bathing even though all of them are being polluted through disposal of sewage and waste by the lake side settlements. Groundwater is one of the most important resources being used as a major source of water supply to serve the needs of the city dwellers.

A small volume of water supply comes from surface water by two water treatment plants, Chandnighat and Saidabad. In 2003, a monthly (October) report of Dhaka Water Supply and Sewerage Authority (DWASA) stated that 84.33% of the total supply of water came from groundwater source and the rest 15.67% was from surface water. Both of the water treatment plants are running with the average capacity of total water production of 264.10 million litres per day (MLD) (July 2002 – October 2002) though the actual average production is 194.72 million litres per day (WASA, 2003). But unfortunately, the groundwater level in many areas of Dhaka city is drastically receding from about 0.3m per year at Banani to about 1m per year at Motijheel (EPC, in Nishat et, al,. 2000).

2.1.4 Biodiversity

The vegetation coverage of Dhaka city has a great variety with indigenous and exotic

Table 2.6 Physical feature of major canals (khal) of Dhaka City

Name	Length (km)	Catchment area (sq. km)
Dholai khal	4.0	16.8
Gerani khal	3.4	6.7
Segunbagicha khal	3.5	8.3
Begunbari khal	6.5	37.7
Total	17.4	69.5

Source: Nishat et. al., 2000

Table 2.7 Physical feature of major lakes of Dhaka City

Name	Length (km)	Area (sq. km)
Dhanmondi lake	2.4	0.176
Ramna lake	4.0	…
Gulshan lake	3.8	0.016
Crescent lake	0.7	0.480

Source: Nishat et. al., 2000

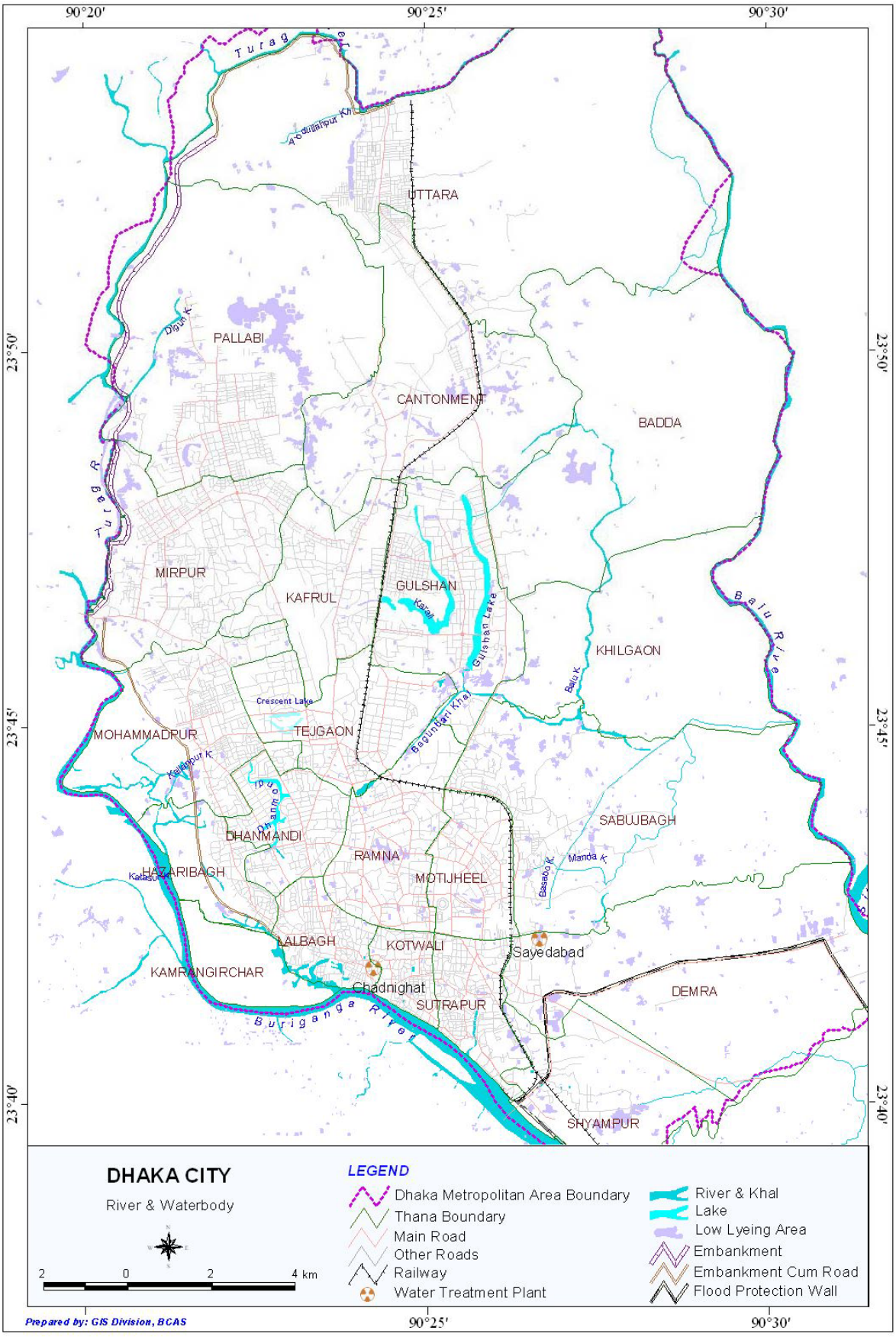


Figure - 2.2 Major Canals and Lakes of Dhaka City

species. According to an estimate of the Arboriculture Division of the Works Ministry, approximately 310 hectares of total area of Dhaka city accommodate parks and gardens (Holiday, March 7, 2003). It is estimated that there are nearly 41-46 parks/gardens in Dhaka city of which Osmani Uddyan, Bahadur Shah Park, Botanical Garden, Zia Uddyan (Garden), Baldha Garden, Suhrawardi Uddyan, Ramna Park etc are mentionable. Of these, Baldha garden, Botanical Garden have a wide variety of plants and trees.

Besides local species, many exotic species were planted along the roadside, old secretariat area and in residential bungalows for the beautification of the city during 1905-06 when Dhaka was the capital of East Bengal and Assam. About 50 species were then planted, of which Aswath (*Ficus religiosa*), Debdaru (*Polyalthia longifolia*), Narikel (*Cocos nucifera*), Ashok (*Saraca indica*), Mahogany (*Sweitana foetida*), Shegun (*Tectona grandis*), Sissu (*Dalbergia sisso*) were very common though many of these species disappeared due to successive floods in 1987, 1988 and 1998 (Rizvi, 1975; GOB, 1993).

The Botanical Garden, which is located at Mirpur in Dhaka city, covers around 84 hectares of land with approximate 50,000 species of trees, herbs, and shrubs including a large collection of aquatic plants, while Baldha garden with about 136 metres in length and 76 metres in width holds around 15,000 plants representing 672 species (Banglapedia, 2003). Many of the species at Baldha garden were collected from over 50 different countries.

It should be noted that many areas (e.g. Mirpur, Dhanmondi, Mohammadpur etc.) of Dhaka city had been covered by natural vegetation during the earlier days. With increased population, industrial and commercial establishments, and construction of roads and highways, most of these have been cleared over the years. From an aerial or bird's eye view the city now looks like a jungle of buildings, apartments, slums and squatters. The Modhupur green area had been a habitat for many animals particularly elephants, tigers, leopards, boars, deer and buffaloes till the beginning of the nineteenth century. Monkeys had also been found in abundance till the mid-nineteenth century (Rizvi, 1975). Foxes, jackals, squirrels and otters have almost disappeared now a days. Bats and rats are still seen sometimes within the city area. A large number of bird species were common in Dhaka, particularly pigeons, doves, kingfishers, parrots, jungle fowl, Common Pea-Fowl (Moyur), kite or cheel, fishing eagle, vulture etc. But many of these are now extinct and the rest are rapidly disappearing. One good point is that a large number of migratory birds are found in Dhaka (especially in the lake of the National Zoo) in winter. Various species of ducks, seagull, falcons, harriers, lawpings, plovers, curlews, and sandpipers etc are also seen here during winter.

Many types of poisonous snakes including (local name) cobra, machhanad, panna, goma, daurhash, dubraj and non-poisonous snakes including ulobora, jinglabora, laudoga, ghauni, dhora, maittya shap etc were very common till 1960s (Rizvi, 1975). A few species like Cobra, Dhora, Matirshap etc. may still be found now a days. The number of amphibians and fishes has gone down in the last few years.

In Ramna park and its surrounding areas beside Minto Road, kingfishers were seen even during 1997-1998 which have almost disappeared. Some monkeys and mongoose were seen in old Dhaka even in the early '60s but their numbers have decreased considerably. They are almost out of sight nowadays. However, it is a well known fact that fisheries biodiversity has been reduced severely due to pollution of surface water. Land ecosystem is also threatened with rapid and unplanned urbanization.

2.2 Social Situation

2.2.1 Population

Population size, growth by both migration and natural, has already made Dhaka a member of the world mega city family. The United Nations and other reports revealed that position of Dhaka mega city was 31st in 1985, 23rd in

species. According to an estimate of the Arboriculture Division of the Works Ministry, approximately 310 hectares of total area of Dhaka city accommodate parks and gardens (Holiday, March 7, 2003). It is estimated that there are nearly 41-46 parks/gardens in Dhaka city of which Osmani Uddyan, Bahadur Shah Park, Botanical Garden, Zia Uddyan (Garden), Baldha Garden, Suhrawardi Uddyan, Ramna Park etc are mentionable. Of these, Baldha garden, Botanical Garden have a wide variety of plants and trees.

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1995 with a population of 8.5 millions, 11th in 2000 with a population of 12.3 millions. It is projected to be 4th in 2015 with a population of 21.1 million. A recent report stated that Dhaka has already become the 5th mega city of the world (Siddiqui and others, 2000; Islam, 1999; UNFPA, 2001; Akash and Singha, 2003).

Increasing trend of population, area and density of Dhaka mega city and DCC in different years are given in Table 2.8 and 2.9, respectively. Thana wise graphical and spatial distribution of population of DCC are also given in Figure 2.3 and 2.4, respectively. Table 2.10 shows population of different thanas from 1981 to 2001 including old (sl. 1 to 12) and new thanas (sl. 13 to 22). Some of the new thanas were formed after 1991 by splitting other existing thanas.

It should be noted that after 1991, number of thanas has increased to 21 in 2003. Some of the major thanas were split to form new thanas viz. Khilgaon and Badda were formed by dividing Gulshan and Motijheel. Mirpur and Cantonment were split to form Pallabi and Kafrul. So, both population and area of the divided thanas decreased. Figure 2.3 shows increasing trend of population of major thanas of Dhaka while also showing decreasing trend of the same thana indicates division to form new units.

Overall poverty is showing reducing trend at national level, but absolute and hard core

Table 2.8. Increasing trend of total population, area and density of Dhaka Mega City

Year	Area (Sq. Km)	Population	% Increase of population over the preceding year	Density (Per Sq. Km.)
1951	85.45	411,279		4813.09
1961	124.45	718,766	74.76	5775.54
1974	335.79	2,068,353	187.76	6159.66
1981	509.62	3,440,147	66.32	6750.41
1991	1352.82	6,844,131	98.95	5059.16
2001	1352.82	10,712,206	56.51	7918.43

Source: BBS, 1991 & 2001

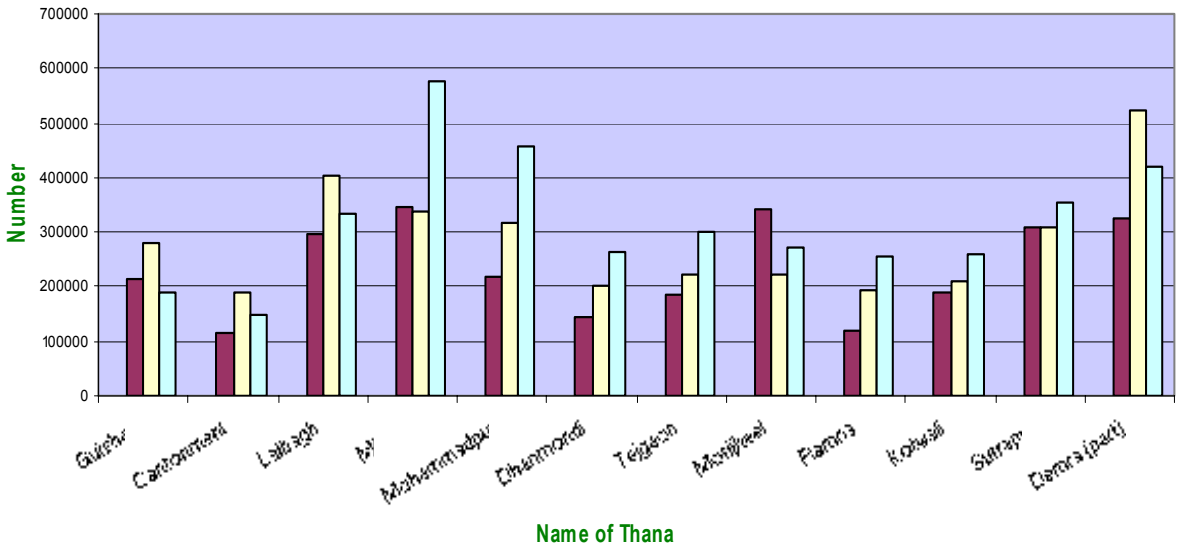

Figure - 2.3. Increasing trend of population of major thana in DCC

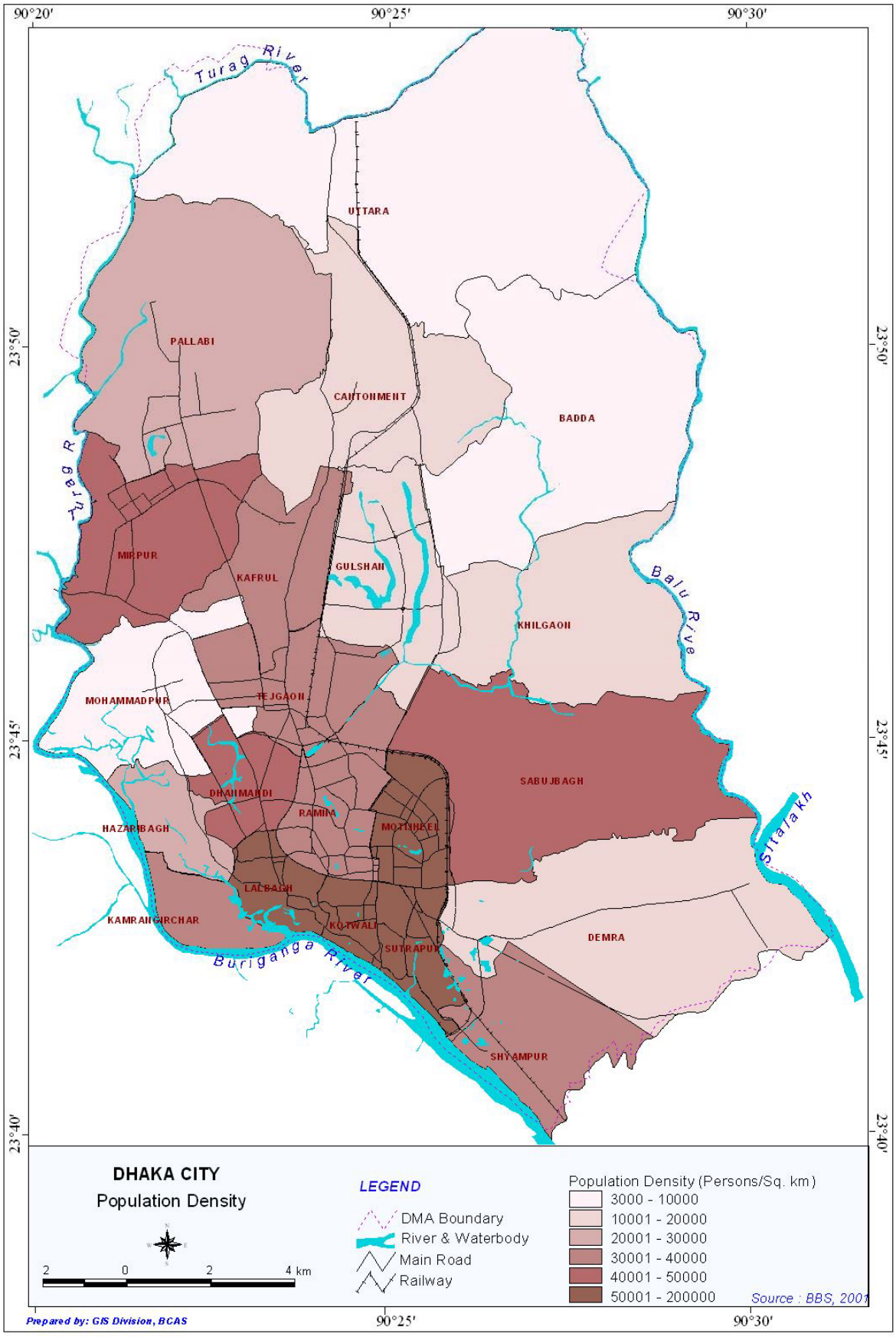

Figure - 2.4 Spatial Distribution of Population in DCC Area

Table 2.9. Increasing trend of total population, area and density of Dhaka City Corporation

Year	Area (Sq. Km)	Population	% Increase of population over the preceeding year	Density (Per Sq. Km.)
1981	208	2,816,805		13,542.33
1991	276	4,486,421	59.27	16,255.15
2001	276	5,378,023	19.87	19,485.59

Source: BBS, 1991 & 2001

Table 2.10. Increasing trend of population of DCC based on Thana

SL	Thana	Area (in Sq. km)	Year		
			1981	1991*	2001
1	Gulshan	10.29	215329	281000	190720
2	Cantonment	14.36	116166	191000	147960
3	Lalbagh	4.08	294659	402000	335040
4	Mirpur	14.22	347416	338000	577440
5	Mohammadpur	12.14	219406	316000	456300
6	Dhanmondi	6.23	142762	202000	263560
7	Tejgaon	8.89	186118	221000	301680
8	Motijheel	4.95	343821	224000	270840
9	Ramna	7.71	119299	195000	255940
10	Kotwali	1.93	188626	210000	261360
11	Sutrapur	3.99	307501	307000	352580
12	Demra (part)	31.10	326123	521000	421540
13	Sabujbagh (part) [Estd. In 1988]	6.74		355000	299820
14	Uttara (part) [Estd. In 1988]	58.85		146,000	351140
14	Hazaribagh [Estd. In 1998]	5.89			135060
15	Kamrangirchar [Estd. In 1998]	3.68			143560
16	Pallabi [Estd. In 1993]	17.96			440180
18	Kafrul [Estd. In 1998]	8.85			295880
19	Badda (part) [Estd. In 1998]	49.85			359380
20	Khilgaon [Estd. In 1998]	20.26			341800
21	Shyampur (part) [Estd. In 1998]	10.94			376340
22	Airport [Estd. In				

Source: BBS, 1983; 1991 & 2001 Enumerated population*

poverty of Dhaka city are 55% and 32% respectively, (GOB-ADB, 1996 in Siddiqui and others, 2000) which is higher than national average . Though the national poverty level has decreased to 49.8% in 2000 from 58.8% in 1991-92, the country status remained the same due to excessive growth of population. But the economic condition of poor of Dhaka is relatively better than the rural areas due to increasing business and trade, city based

commercial and industrial development, multinational business and cooperation etc.

There are large number of primary and, secondary schools, colleges and universities in Dhaka city. Some of these universities also offer postgraduate degrees on environment. The adult literacy rate in urban area is 69.3% (BBS, 2001). But another report states that the illiteracy rate of Dhaka city population is 45.2% of which 53 % are women (World Bank, 1999 in Siddiqui and others, 2000).

2.2.2 Nutrition and Human Health

Detailed research on the nutrition intake of Dhaka city dwellers is not available but the national nutritional status offers the following information (Anowar, 2000):

- Calorie intake, 1995-96: 2244
- Protein intake (gm),1995-96: 65
- Per Capita food consumption (gm), 1997-98: 172.2

In Bangladesh, the mortality and morbidity are determined based on the reported incidences of 31 selected diseases at the national level. According to the Health Bulletin 1999 of the Ministry of Health and Family Welfare, 10 common diseases are dominating both mortality and morbidity rates in Bangladesh. Of them, pneumonia has the highest rate of mortality at national level. Respiratory disorders, diarrhea, malaria, skin disease, intestinal worm infection, peptic ulcer and anemia cause huge morbidity in both Dhaka and at the national level (Anowar, 2000). Table 2.11 shows the estimated specific health status in Bangladesh (national) in 2001.

Table 2.11. Estimated specific health status in Bangladesh

Crude mortality rate	4.8 per 1000 population
Infant mortality rate	56 per 1000 live births
Mortality rate under five	77 per 1000 live births
Maternal mortality rate	3.1 per 1000 live births

Source: Statistical Pocketbook of Bangladesh 2002

It is assumed that due to the increasing level of degradation and pollution of air, water, noise and land, the health condition of Dhaka City people has severely deteriorated. According to a SEHD study, morbidity rate of tannery workers is 893.85/1000 whereas average morbidity rate of Bangladesh is 150.92/1000 (Khan, 2003).

2.2.3 Human Settlement

The settlement is very critical for Dhaka city as the population growth is very high. As mentioned earlier, DCC has only 276 km^2 area that accommodated a population of over 5.3 millions in 2001. An estimation of JICA shows this population of DCC became over 5.9 millions in 2004. Except a few residential areas like Dhanmondi, Gulshan, Banani, Baridhara, Uttara etc., all other areas are for mid and low income groups. About 30% of the total population of Dhaka live in 3,007 informal settlements. It is reported that 70% of the total population live in only 20% of the residential land while the rest 30% live in 80% of the residential land in Dhaka city, which shows the large unequal distribution of settlements (Akash and Singha, 2003). According to Professor M. M. Akash of the University of Dhaka and Dr. Dibalok Singha of the Dusthya Shasthya Kendra (DSK), about 30 to 35% of the total population of Dhaka live in slum areas with 1700 to 10,400 people per hector, which is highly overcrowded, rendering the living

Box 2.2: Employment

The study to determine the employment rate in Dhaka or even in Bangladesh in any specific sector, both public and private, is limited. However, according to an available report, the employment situation of Dhaka city dwellers is as follows.

- Informal activities: 24%
- House hold work: 28%
- Other Services: 25%
- Unemployed: 23%
- Employed: 77%

Source: Fukuoka Conference, 2000

The high concentration of tanneries in the Hazaribagh area is the main source of water, air, soil pollution resulting occupational health problems.

conditions totally unhygienic (Akash and Singha, 2003). Moreover, most of the slums do not receive the city water supply and sanitation services; hence they have insufficient water for daily use, throw waste here and there, and cook food very close to their living quarters. The slum of Dhaka is showing an increasing trend over time.

In 1988, there were only 1125 slums and squatter settlements in the city and the number had increased to 3007 by 1996 (Islam, 1996 and DCC, 2004), of which hardly any gets any form of municipal solid waste management services along with other amenities.

2.3 Key Sectors and Concern

2.3.1 Industry

The establishment of industry and factory in Dhaka was largely started after the independence, though from the Mughal to Pakistan period (till 1962), the total number of industries was about 100, located in Postagola, Lakshmibazar, Imamganj, Gandaria, Farashganj, Faridabad, Shankharibazar, Nawabganj, Amligola, Tantibazar, Patuatuly, Hazaribagh and Tejgaon (Islam, 1996; Rizvi, 1975). Most of these industries were small/ medium scale and were located all over the present old town and Tejgaon, a planned industrial area which has an area of 238 hectors. This area was designated for small and medium scale industrial establishments. However, the Muslin-embroidery-textile was the initial industrial movement in Dhaka from the beginning of its history. These industries were located in and around Dhaka city.

The Dhaka Cotton Mills was established at Postagola in 1938. A number of handloom factories were also established in old town (Rajani Bose Lane, Chittaranjan Avenue, Mitford Road) and in Tejgaon. A few indigo industries were established in Nawabganj area. Besides these, perfumery, conch shell, horn carving, gold and silver smithy, filigree, soap, boat building, tannery, glass, match, oils, iron and steel industries were also found till independence. Most of them were located at either old town or Tejgaon. Some of them were found in Mirpur area, for example, Prince Iron and Steel Industries, Mirpur Ceramic Works, Bux Rubber Co. Ltd. etc.

After the independence, a large number of industries were established in Tejgaon and Hazaribagh area. The number of tanneries has increased to over 200 now from 26 in 1975 (Rizvi, 1975). Nearly 2000 garments industries have been established all over the city starting during the early '80s. However, after the independence, the number of total industries has increased to about 1,200 (IGES, 1998). Of these jute, tannery, dying and textile, printing, metal, cement, rubber, chemicals and pesticides, battery, petroleum refinery, distillery, plastics, brick manufacturing etc were established in a rapid and unplanned manner in different places of the city (IGES, 1998; Siddiqui and others, 2000). Tejgaon has been built up with a mixture of large industries, which might be the main source of air and water pollution in the city, especially the SPM concentration which has already exceeded the International Standard. The high concentration of tanneries in the Hazaribagh area is the main source of water, air, soil and even occupational health problems for the people living and working in that area. The numerous industries established in Postagola may be responsible for the localized pollution of air and water (Siddiqui and others, 2000).

2.3.2 Transportation Services and Management

According to the National Encyclopedia of Bangladesh (Banglapedia), the roads of Dhaka city occupy only 8% (2,230 km) of the total surface area whereas according to standards, at least 25% is required to facilitate a smooth transport system (Banglapedia, 2003). The width of the city roads vary from 6m to 40m, though some of the roads are found to be less than 6m in width in the old town (Meenar, 2000). The total length of the DCC roads in another report is 1,968 km, (Rahman, 1998) but according to DCC officials, the length is 2,300 km, of which 200 km are main thoroughfares, 110 km secondary roads, 152 km feeder roads and the rest are narrow lanes and by-lanes (The daily Star, January 18, 2004). The transport

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network of Dhaka city is shown in Figure 2.5.

It is important to note that 300,000 rickshaws of Dhaka city account for 56% of the total vehicles which occupy 73% of its road surface (Ahmed, 1998 in Siddiqui and others, 2000). But the DCC has the registration for only 88,000 rickshaws (The Daily Star, Oct 26, 2003). The total number of registered motor vehicles up to 2002 in Dhaka was 293,973, which accounted for 39% of the total transport mode, whereas walking and rickshaws share 45.8% and 15.2%, respectively (BRTA, 2001). However, the government has taken initiatives to remove unregistered rickshaws and restricting their movement in some of the main roads.

With rapid urbanization and excessive growth of population and settlements, the city failed to upgrade its road transport and network system, even though the growth of motor vehicles per year is about 6-7%, which is equal to or may even be more than the average population growth, (Siddiqui and others, 2004; DTCB, 2002). Of the proposed total of 59 electronic traffic signals, a few have already been installed in different parts of the city, particularly, in Gulshan and Dhanmondi. This will be controlled by the DCC as soon as the installation is completed. According to a daily newspaper, nearly 80% of the licenses of taxicabs are illegal though they regularly ply the roads along with the huge number of non-motorized vehicles (rickshaws) and create severe traffic congestion (The Daily Star, 22 September, 2003).

Bangladesh Road Transport Authority (BRTA), with the total manpower of 291, is responsible for the control and management of road transport (BRTA, 2004). The Dhaka Metropolitan Police (DMP) is responsible for traffic management. The DMP comprises a total of 2,008 people including 479 traffic sergeants and 1,406 constables (DMP, 2004). These two organizations work as the supreme authority of controlling the total road transportation and managing the traffic of Dhaka city, with the necessary participation of a few other organizations such as the DoE, DCC, BRTC and the private transport sectors.

Bangladesh Inland Water Transport Authority (BIWTA) deals with the development, maintenance and control of inland water transport. The river port established on the Buriganga River at the extreme south end of the city is used for water transport communication to all over the country.

Bangladesh Railway is responsible for railway communication throughout the country. The largest station, the Kamalapur Railway Station, is situated at Kamalapur, close to the Motijheel area.

The Civil Aviation Authority of Bangladesh (CAAB), an autonomous body is situated in the northern part of Dhaka. CAAB deals with all the aspects of aviation including airports, runways and air traffic control, control towers, operation and administrative buildings, car parking, air navigation, radio communication system, etc. The Zia International Airport is sited close to the CAAB building. Both domestic and international flights are handled at this airport.

2.3.3 Health Care Infrastructure and Services

The Ministry of Health and Family Welfare of the Government of the People's Republic of Bangladesh implements all health policies, plans and activities through the Director General of Health Services and Director General of Family Planning. Director General (DG) Health supervises all public health related activities including hospital service. A recent report of JICA stated that around 288 hospitals and diagnostic centres in Dhaka city provided 12,093 beds (JICA, 2004). In fact, the major medical college, hospitals and institutions of the country are situated in Dhaka. But compared to the population of the city, the ratio of the number of doctors to patients is not adequate.

DCC has its own health services department to control the infectious diseases and maintains a number of hospitals and dispensaries that may serve as centers for emergency medical relief for the city dwellers. DCC maintains 6 hospitals and maternity clinics, 90 primary

Figure - 2.5 Road and Transportation System of Dhaka City

health service centres under UPHCP, 17 charitable dispensaries and 3 homeopathy laboratories for better health care of city dwellers. The primary health centers are located in 10 different zones of DCC.

According to the Health and Population Statistical Report 1999-2000, there are 5 Post Graduate Institutes, 4 Health Research Institutes, 2 public medical colleges, 1 public dental college, 1 Paramedical Institute, 1 Nursing Training Centre, 1 Public Medical University, 9 private medical colleges and 5 private dental colleges in Dhaka City. These provide academic, research and training in order to educate the people. Nursing education is satisfactorily improving though the quality of the education of the private medical colleges is still under scrutiny and considered not as valuable as education from public institutions.

2.3.4 Occupational Health and Safety

A large number of people are involved in industrial and utility service jobs, but most of the industries do not adopt precautionary and safety measures for the workers. Millions of people work in Hazaribagh tannery, Tejgaon industrial area, textile mills, dyeing and other factories in Postagola, municipal solid waste management, motor and refrigerator repairing workshops and garments industries all over Dhaka. All these workers are substantially exposed to occupational health risk through inhalation, skin contact and ingestion route of hazardous chemicals. Tannery, battery, textile and dyeing industries should provide enough safety measures in their industrial operation but they hardly adhere to the safety regulations required to protect worker's health. Every single tannery worker is exposed to hazardous chemicals that are released from tannery processing and operation. Surprisingly, 40% of the total workers are children (Khan, 2003). This direct and chronic exposure of such chemicals might have significant carcinogenic and long-term non-carcinogenic effect on the health of the workers, especially the children.

According to a recent study of NIPSOM and Bangladesh Medical College, many rickshaw pullers and vehicle drivers suffer from hearing difficulties (Hasan and others, 1998). This may be due to their chronic exposure to higher level of sound from vehicular horns and other sources. Municipal solid waste workers should wear masks and hand gloves to avoid microbial infection but very few use it.

Welding shops exist at almost every of road side and market places. Workers used to welding without wearing goggles. Very few are seen using any protective shield. Due to such practices both workers and passersby are affected greatly in the process.

2.3.5 Water Supply and Sanitation

The city has a current demand of over 2000 million (2 billions) liters of water per day but WASA can only deliver 1300 to 1500 million liters per day, covering about 55% of the city (Sharmin and Rainer, 1999; WASA, 2003, 2004). The city with millions of people generate about 1.3 millions of m^3 of sewage everyday of which hardly 40,000 m^3 gets treated by the only sewage treatment plant at Pagla, which is under the management control of WASA. WASA was established in 1963 for the water supply and sanitation services of Dhaka City (The New Age, 16 April, 2004). The rest of the total generated sewage of Dhaka city directly goes into the river system of the city through open drains and canals.

2.3.6 Waste Generation and Disposal

The city generates around 4,000 tons of solid waste of which nearly 50% is collected and disposed off in the municipal landfill sites in Matuail, *Berri Band* (side of embankment), Uttara (see section 3.6 for details).

2.4 Environmental Legislation and Management

In 1989, the Ministry of Environment and Forest (MOEF) established the Department of Environment (DoE) to investigate and control the environmental situation of Bangladesh through enforcement of existing environment related laws, policy and guidelines. Some of the acts and regulations were newly introduced and also amended by the government with

health service centres under UPHCP, 17 charitable dispensaries and 3 homeopathy laboratories for better health care of city dwellers. The primary health centers are located in 10 different zones of DCC.

According to the Health and Population Statistical Report 1999-2000, there are 5 Post Graduate Institutes, 4 Health Research Institutes, 2 public medical colleges, 1 public dental college, 1 Paramedical Institute, 1 Nursing Training Centre, 1 Public Medical University, 9 private medical colleges and 5 private dental colleges in Dhaka City. These provide academic, research and training in order to educate the people. Nursing education is satisfactorily improving though the quality of the education of the private medical colleges is still under scrutiny and considered not as valuable as education from public institutions.

2.3.4 Occupational Health and Safety

A large number of people are involved in industrial and utility service jobs, but most of the industries do not adopt precautionary and safety measures for the workers. Millions of people work in Hazaribagh tannery, Tejgaon industrial area, textile mills, dyeing and other factories in Postagola, municipal solid waste management, motor and refrigerator repairing workshops and garments industries all over Dhaka. All these workers are substantially exposed to occupational health risk through inhalation, skin contact and ingestion route of hazardous chemicals. Tannery, battery, textile and dyeing industries should provide enough safety measures in their industrial operation but they hardly adhere to the safety regulations required to protect worker's health. Every single tannery worker is exposed to hazardous chemicals that are released from tannery processing and operation. Surprisingly, 40% of the total workers are children (Khan, 2003). This direct and chronic exposure of such chemicals might have significant carcinogenic and long-term non-carcinogenic effect on the health of the workers, especially the children.

According to a recent study of NIPSOM and Bangladesh Medical College, many rickshaw pullers and vehicle drivers suffer from hearing difficulties (Hasan and others, 1998). This may be due to their chronic exposure to higher level of sound from vehicular horns and other sources. Municipal solid waste workers should wear masks and hand gloves to avoid microbial infection but very few use it.

Welding shops exist at almost every of road side and market places. Workers used to welding without wearing goggles. Very few are seen using any protective shield. Due to such practices both workers and passersby are affected greatly in the process.

2.3.5 Water Supply and Sanitation

The city has a current demand of over 2000 million (2 billions) liters of water per day but WASA can only deliver 1300 to 1500 million liters per day, covering about 55% of the city (Sharmin and Rainer, 1999; WASA, 2003, 2004). The city with millions of people generate about 1.3 millions of m^3 of sewage everyday of which hardly 40,000 m^3 gets treated by the only sewage treatment plant at Pagla, which is under the management control of WASA. WASA was established in 1963 for the water supply and sanitation services of Dhaka City (The New Age, 16 April, 2004). The rest of the total generated sewage of Dhaka city directly goes into the river system of the city through open drains and canals.

2.3.6 Waste Generation and Disposal

The city generates around 4,000 tons of solid waste of which nearly 50% is collected and disposed off in the municipal landfill sites in Matuail, *Berri Band* (side of embankment), Uttara (see section 3.6 for details).

2.4 Environmental Legislation and Management

In 1989, the Ministry of Environment and Forest (MOEF) established the Department of Environment (DoE) to investigate and control the environmental situation of Bangladesh through enforcement of existing environment related laws, policy and guidelines. Some of the acts and regulations were newly introduced and also amended by the government with

regard to the existing environmental, land use, and agricultural laws, which would largely and legally support the Department of Environment. The environment related laws, policy and guidelines made by the government so far are given in Table 2.12.

2.4.1 Regulatory Bodies and Implementing Agencies

Ministry of Environment and Forest, deals with the planning, promotion, coordination and overseeing the implementation of environmental and forestry programme. The Department of Environment, carries out the policy analysis, planning and evaluation, programme coordination, and monitoring and evaluation of the environmental programs. On the other hand, Forest Department deals with the forestry programmes.

Dhaka City Corporation, under the Ordinance 1983, is responsible for 13 compulsory functions (Siddiqui, 2004). These are

1. *Construction and maintenance of roads, bridges and culverts;*
2. *Removal, collection and disposal of refuse, waste and rubbish;*
3. *Maintenance and watering of public streets;*
4. *Regulation of private sources of water supply;*
5. *Construction and maintenance of private markets and shopping centers;*
6. *Plantation of trees on roadsides;*
7. *Regulation of unsanitary buildings;*
8. *Prevention of infectious diseases and epidemics;*
9. *Registration of births, deaths and marriages;*
10. *Provision and maintenance of slaughterhouses;*
11. *Provisions and maintenance of graveyards and cremation grounds;*
12. *Control over traffic and public places;*
13. *Control and regulation of milk supply.*

The DCC is also obliged to carry out any activities given by the central government. There are 16 Departments at present, namely Establishment, Engineering, Revenue, Accounts, Social Welfare, Urban Planning, Slum Development, Estate, Transport, Audit, Public Relations, Law, Conservancy, and Information Technology to perform the mentioned activities.

DWASA was established in 1963 to supply safe drinking water and provide sewerage facilities to the city dwellers. Currently, the service area of DWASA is confined in 8 zones (seven are located in DCC area and one is in Narayanganj). The building, developing, maintaining, repairing, rehabilitating the necessary infrastructure for water supply and sewage management are the major functions of DWASA. DWASA has three departments to perform these designated functions. These are Operations; Finance, administration and commercial; Planning, Research and Development.

There are a few academic and research institutions, which offer degrees on environmental science and engineering, and are involved in environmental study and research. The following are located at Dhaka:

- *Bangladesh University of Engineering and Technology (BUET)*
- *University of Dhaka*
- *North South University (NSU)*
- *Independent University of Bangladesh (IUB)*
- *Jahangir Nagar University, Bangladesh*
- *Bangladesh Council of Scientific and Industrial research (BCSIR)*
- *Bangladesh Centre for Advanced Studies (BCAS)*
- *Bangladesh Institute of Development Studies (BIDS)*
- *International Union for Conservation of Nature (IUCN)*
- *Bangladesh Environmental Lawyers Association (BELA)*
- *Centre for Environment and Geographic Information Services (CEGIS)*

Table 2.12 Environment related policies and laws

Law/ Act/ Guideline	Environmental component/sector
Master plan for solid waste management for Dhaka city (On process)	Solid waste management
City Corporation Acts/Ordinances	(all) inner city Environmental Management
The Public Parks Act 1904	Parks, Recreation Spots
The Forest Act 1927	Forest
Motor Vehicles Act, 1939	Air, noise
Town Improvement act, 1950	Land use
The Building Construction Act 1952	Construction of buildings/ houses
The Private Forest Ordinance 1959	Private Forests
Factories Act, 1965	Air, occupational hazards
Pesticide Ordinance, 1971	Agriculture
Bangladesh Wildlife (Preservation) Order 1973	Wildlife, forests
Traffic law, 1983	Air, noise
Irrigation Water Rate Ordinance 1983	Agriculture
Groundwater Management Ordinance 1985	Ground water
Brick Burning Control Act, 1989	Air, land
Environment Policy, 1992	Air, water, land, health
Atomic Security & Radiation Control Act 1993	
National Forestry Policy 1994	Vegetation
Environment Conservation Act, 1995	Air, water and noise
Water Supply and Sewerage Authority Act 1996	Water, sewage
Environmental Conservation Rules, 1997	Air, water and noise
EIA guidelines of industries, 1997	Air, water, noise
Dhaka Metropolitan Development Plan, 1997	Land use
Water Supply and Sanitation Act, 1998	Water and sanitation
National Fisheries Policy 1998	Water, aquatic habitat
National Water Policy, 1999 (approved)	Water
National Agriculture Policy 1999	Land use
Industrial Policy 1999.	Air, water
Environment Court Act, 2000	Air, water, land etc
Open Space and Wetland Protection Act, 2000	Land
Bangladesh Water Development Board Act 2000	Water, agriculture
Urban Water Body Protection Law 2001.	Water
Noise Control Act, 2004	Noise
National Water Management Plan, 2004	Water
Municipal Ordinance, 1977(amended in 1983)	Land use, water, solid waste management

Source: JICA, 1999; Huq, 2004

2.4.2 Environmental Jurisprudence

The Department of Environment holds the legal base for the conservation and management of the environment of Bangladesh. According to the Environment Conservation Act 1995, the DoE has the right to initiate legal proceedings against any environmental violation through the Director General. If anyone contravenes any provision of the act, the charge is no more than one lakh taka (0.1 million) or punishable with imprisonment with no more than five years or both. However, after the DoE carries out the legal proceedings, the magistracy/judiciary can only implement the physical closure of non-compliant unit.

2.4.3 Recent Initiatives

A number of programmes have been initiated in the environmental sector of Bangladesh to help in the protection and conservation of the environment. Some of these are the Bangladesh Environment Management Programme (BEMP), Sustainable Environment Management Programme (SEMP), Knowledge and Research (KAR) and Asia Pro Eco. Besides these, the government, NGOs and international organizations are also involved with both technical and financial support in the environmental management of Bangladesh.

The Department of Environment (DoE), Bangladesh Poribesh Andolon (BAPA), Bangladesh Centre for Advanced Studies (BCAS), Waste Concern and a few other local and international NGOs initiate public awareness programmes and exchange environmental information.

2.4.4 Transparency and Accountability

All core government agencies are officially empowered with relevant laws, policies, guidelines and other logistic supports to keep the city environmental friendly and livable. But many of these agencies may have practices of lack of transparency and accountability. Dhaka City Corporation is the main authority with many compulsory activities of which municipal solid waste management, maintenance of roads, bridges and culverts, construction and maintenance of private markets and shopping centres, prevention of infectious diseases and epidemics are noteworthy. The bumpy and pitted roads, improper solid waste management and poor initiative against infectious diseases and epidemics partially contribute to the gap of transparency and accountability of the DCC.

2.4.5 Capacity and Resources

The city authority has limited funds for utility service management and development activities. In 2000, JICA recommended that the DCC should have at least 510 conservancy vehicles and trucks for proper waste collection, transportation and disposal, whilst the DCC had only 382 conservancy vehicles at that time (DCC, 2000). They also stated that the DCC should increase 25% of conservancy vehicles every five year but due to financial constraint DCC currently has only 370 trucks and container carriers, a number that has surprisingly decreased rather than increasing.

2.2.6 Public Awareness

A large number of people of Dhaka may still be unaware about the environment, how it gets polluted and why it should be protected. According to Professor M M Akash of the University of Dhaka and Dr. Dibalok Singha of the Dusthya Shasthya Kendra (DSK),, slum dwellers are living in a unhygienic condition and polluting through regular activities i.e. burning of biomass, unsanitary practices etc. Lack of awareness and services have identified as major cause behind it. Many farmers in the city area use pesticides but they are not aware of the harmful effects of these in the long run and how these should be handled and applied to the fields.

3. Key Environment Issues

Nine key environmental issues have been identified by the stakeholders at the inception workshop and the national stakeholder consultation meeting. These are air, water, land, noise, solid waste management, sewage management, slums and squatters, environmental health and natural disaster. This section provides in depth analysis of each of the issues mentioned above.

3.1 Air

Air, the most integral part of the physical environment, sustains life of both plant and animal kingdoms including human beings. Animals take in the major constituent, oxygen from the air giving out carbon dioxide, and plants take in carbon dioxide, giving out oxygen during photosynthesis. Both land and aquatic ecosystems are naturally interrelated through direct participation of air, an invisible ocean.

Degradation of the quality of the environment, including that of the air due to anthropogenic activities has now emerged as a major concern all over the world. It is for this reason that 113 nations and other stakeholders from developed and developing world had joined in the first conference on environment -- The United Nations Conference on Human Environment -- to discuss the common environmental issues in Stockholm in 1972, which was later named as the "Stockholm Spirit of Compromise" (UNEP, 2002). However, with the growth of mega cities in Asia-Pacific region, air pollution has come at the top of the key environmental issues in the region. Additional environmental impacts of air pollution include damage to buildings and structures, agricultural crops, vegetation and forests; and reduced visibility. Air quality in Dhaka is a serious issue in view of the magnitude of its health and economic impacts. Although some measures have already been taken to improve the air quality in Dhaka, considerable effort will be needed in the coming years to improve quality to meet the standards.

A "business as usual" development will result in further environmental damage. Asia's particular style of "urbanization toward mega cities" is likely to further exacerbate environmental and social stresses (GEO, 2000).

3.1.1 Status of Air Quality in Dhaka

Economic, industrial and demographic growths are driving urbanization in Bangladesh as it is in the other developing countries. Emergence of urban conurbation of extremely high population density is affecting the quality of life in many different ways. Uncontrolled emissions from motor vehicles and other economic activities give rise to air and other forms of pollution. High levels of emission of air pollutants in a small area exceed the processes of dilution and dispersal, leading to severe episodes of ambient air pollution. Fairly comprehensive air quality data are being collected for Dhaka nowadays (AQMP (2002-04) and Biswas et al (2001, 2004)). The summary of air quality data for Dhaka obtained at the Continuous Air Monitoring Station

Table 3.1. Average values for Criteria Pollutants Measured at CAMS, Dhaka with standard deviations during 2003 along with Bangladesh Standards (Source-AQMP (2002-04).

Pollutants	Averaging Time	Who Guidelines	Bangladesh Standards	Annual average Concentration during 2003
CO	1 hour	30 mg/m^3	40 mg/m^3 (35 ppm)	---
	8 hour	10 mg/m^3	10 mg/m^3 (9 ppm)	1.0 ± 0.8ppm
SO_2	24 hour	125 mg/m^3	365 mg/m^3 (140 ppb)	----
	Annual	50 mg/m^3	80 mg/m^3 (30 ppb)	7±8 ppb
NO_2	24 hour	---	---	---
	Annual	40 mg/m^3	100 mg/m^3 (53 ppb)	59±58 ppb
Ozone	1 hour	---	235 mg/m^3 (120 ppb)	
	8 hour	120 mg/m^3	157 mg/m^3 (80 ppb)	28±20 ppb
PM_{10}	24 hour	---	150 mg/m^3	
	Annual	---	50 mg/m^3	133 ± 78mg/m^3
$PM_{2.5}$	24 hour	---	65 mg/m^3	---
	Annual	---	15 mg/m^3	76 ± 57mg/m^3

(CAMS) of the Department of Environment is shown in Table 3.1.

It can be seen from Table 3.1 that the main pollutant of concern in Dhaka is particulate matter. Both PM_{10} and $PM_{2.5}$ levels are extremely high, being much above the proposed standard. The NO_2 levels are also now close to the limit and may become a concern in the future. The levels of other pollutants are still low and thus are not important from health point of view. Lead (Pb) concentration is not shown in the table. The Pb level is now sufficiently low (i.e. around 100 ng/m^3) and therefore airborne lead is no longer considered a health issue (Biswas et al, 2003). However, blood lead levels in children are still high (Kaiser et al, 2001) indicating that other sources of lead may exist.

Investigation using the receptor-modelling approach to identify sources of particulate air pollution has been reported (Begum et al, 2005). Seven components have been found in the coarse PM ($PM_{2.2\text{-}10\mu}$) and six components have been found in the fine ($PM_{2.2\mu}$) particulate matter. The major sources are motor vehicle emission, re-suspended road dust, biomass burning, and construction and fugitive sources. The fugitive sources probably include industrial emissions. In the $PM_{2.2}$ fraction about 50% of the contributions come from motor vehicles.

The economic valuation of the air pollution revealed that between US$ 121 to 353 million per year (2003 estimate) can be saved in Dhaka as health cost if the PM_{10} pollution level is reduced by a modest 20% of the current level and to the proposed national standard (Khaliquzzaman, 2005a). Details of emission sources are given below.

Emission from Motor Vehicles

The absolute number of motorized 3-4 wheel vehicles plying on the city street is not large, being only about two hundred thousand. However, the emissions from the vehicles are substantial due to low technology of the vehicle fleet, weak maintenance culture, overloading and over-fuelling of heavy duty

Photo - 3.1. Traffic Congestion in Motijheel area

vehicles among other causes. Most of the private operator fleets consist of highly polluting old vehicles. These transport companies have limited resources for operation and maintenance. Poor maintenance coupled with poor fuel quality, congestion (see Photo 3.1) and poor transport infrastructure exacerbate the vehicular air pollution in the city. Details of vehicle statistics and their emission and emission factors are given in Table 3.2 - 3.6 and Figure 3.1.

As pointed out earlier, the main pollutants of concern in Dhaka are the particulate matter and motor vehicles are major contributors to PM pollution. Most of the vehicular PM pollution (> 80%) comes from the diesel vehicles in Dhaka (Table 3.6). This is also the situation for NO_x and SO_2. Thus major policy decisions in respect of diesel vehicle pollution control are imperative. The gasoline vehicles contribute more to CO and HC pollution. The ambient concentrations of these pollutants are still low and thus gasoline vehicle pollution management is not yet a major issue. The major gain in PM pollution reduction from the baby-taxi ban in January 2003 (see box 3.1) is being progressively lost due to increasing pollution from diesel vehicles.

Dhaka Metropolitan Development Plan (DMDP) was prepared in 1997 by RAJUK to be used in all sectoral development in an integrated manner. However, it is unfortunate that the current development process of Dhaka city still may not be following the recommendations of the DMDP. The

Table 3.2. Number of Year Wise Registration of Motor Vehicles in Dhaka

Type of Vehicles	Before 95	1995	1996	1997	1998	1999	2000	2001	2002	Total
Motor Car	36998	6923	8386	6528	4984	4330	2452	5560	5542	81703
Jeep/St. Wagon/ Microbus	17937	1556	1387	1492	1438	1371	910	1579	2911	30581
Taxi	787	25	35	14	102	215	348	762	2101	4389
Bus	169	145	73	58	184	224	202	453	632	2140
Minibus	2009	324	167	397	300	215	242	831	1924	6409
Truck	9775	802	615	834	1681	855	1635	890	1127	18214
Auto-rickshaw/ Tempo	8359	7301	4615	1902	1689	682	1881	75	2616	29120
Motor-Cycle	61478	4427	4027	5346	4992	5330	8768	8590	9102	112060
Others	2063	878	828	310	196	1326	819	1825	1012	9257
Total	**139575**	**22381**	**20133**	**16881**	**15566**	**14548**	**17257**	**20565**	**26967**	**293873**

Source: DTCB, 2004

Table 3.3. Vehicular Emission Inventory of Dhaka City in 2004 (Tons/year)

Sl	Vehicle	km/ day	Number (2004)*	CO	NOX	SO_2	HC	PM-10
1	Cars	40	130,827	47,752	2,865	153	7,640	191
2	Taxis-CNG	130	8,600	2,040	612	0	816	12
3	3W Taxis-CNG	130	11,500	2,728	819	0	1,091	16
4	LD Diesel	60	25,623	2,806	4,770	224	1,122	449
5	Buses	130	12,370	5,870	9,978	470	2,348	939
6	Trucks	60	19,307	4,228	7,188	338	1,691	677
7	Motorcycles	30	116,320	6,369	382	25	5,095	127
	Total			71,793	26,614	1,211	19,804	2,412

* *Projected from BRTA figures for 2003 with reclassification of vehicle according to emission category (Khaliquzzaman, 2005b). Inter-district buses have not been considered in calculating the inventory.*

Table 3.4. Emission factors in grams/km and vehicle usage in Dhaka (contingent estimates from available data from different sources)

	Emission Categories	Km/Day	CO	NOX	SO_2	HC	PM-10
1	LD Gasoline Vehicles	40	25.00	1.50	0.08	4.00	0.10
2	CNG Taxis	130	5.00	1.50	0.00	2.00	0.03
3	CNG Autorickshaws	130	5.00	1.50	0.00	2.00	0.03
4	LD Diesel Vehicles	60	5.00	8.50	0.40	2.00	0.80
5	Buses	130	10.00	17.00	0.80	4.00	1.60
6	Trucks	60	10.00	17.00	0.80	4.00	1.60
7	Motorcycles	30	5.00	0.30	0.02	4.00	0.10

Table 3.5. Vehicular Emission in 2004 (in percentage) in Dhaka

Sl.	Vehicle Type	Emission (%)				
		CO	NOX	SO_2	HC	PM-10
1	Cars	66.5	10.8	12.6	38.6	7.9
2	Taxis-CNG	2.8	2.3	0.0	4.1	0.5
3	3W Taxis-CNG	3.8	3.1	0.0	5.5	0.7
4	LD Diesel	3.9	17.9	18.5	5.7	18.6
5	Buses	8.2	37.5	38.8	11.9	38.9
6	Trucks	5.9	27.0	27.9	8.5	28.1
7	Motorcycles	8.9	1.4	2.1	25.7	5.3
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Khaliquzzaman, 2005

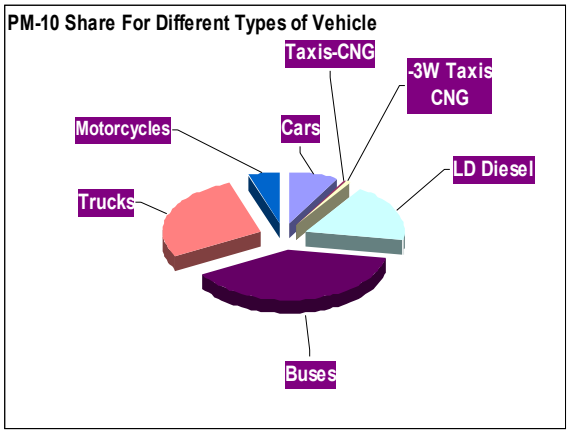


Figure - 3.1. Proportion of PM10 Emission from Different Categories of Vehicle in 2004

recommendation was to implement all sectoral/ utility development as short term (1995-2000), mid-term (2000-2005) and long-term (2005-2010) plan. Mid-term period is over but many of the developments have not started or been implemented yet; for example, subway development, commuter light railway and sufficient pedestrian facility programmes in the city area.

However, the government has taken several initiatives and policy decisions (Box-3.2) to update the existing environmental acts, rules and regulations for environmental improvement in general and air quality improvement in particular.

Enforcement of all the environmental laws and regulations remains a major issue to be tackled in the future. Some of the policies and laws are as follows:

- Environment Conservation Act, 1995 (amended in 2000 and 2002)
- Environment Court Act, 2000 (amended in 2002)
- Environment Conservation Rules, 1997
- Motor Vehicle Ordinance, 1983 (amended in 1988)
- Dhaka Metropolitan Police Act, 1976
- Environment Policy, 1992

Besides laws, policies and guidelines, the government has taken a few other initiatives to improve and better transport and traffic management. The noteworthy initiatives are:

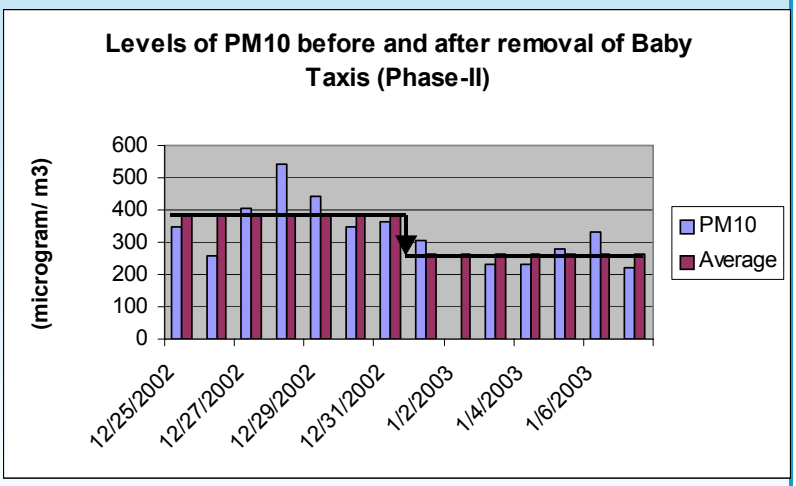
- Dhaka Integrated Transport Study (DITS) conducted during 1991-1992 to determine the transport status of Dhaka.
- Dhaka Transport Coordination Board (DTCB) established in 2001 to develop an innovative transport policy and guidelines for the improvement of transport status of Dhaka city.

Table 3.6. Dhaka vehicular emission in 2004 for diesel and non-diesel vehicles (in percentage)

Vehicle	Emission (%)				
	CO	NO_X	SO_2	HC	PM-10
Diesel Vehicles	18.0	82.4	85.3	26.1	85.6
Non-diesel Vehicles	82.0	17.6	14.7	73.9	14.4

Source: Khaliquzzaman, 2005

Box 3.1. Eliminating Emissions from Two-stroke Engine Baby-taxis in Dhaka



Two-stroke engined gasoline-fuelled three-wheelers, nicknamed "baby-taxis," provided useful point-to-point transportation for passengers but were major sources of particulate and hydrocarbons air pollution in Dhaka, Bangladesh. Numbering around 50,000, their emissions were exacerbated by the use of inferior-quality and excess use of lubricant (called straight mineral oil). These polluting vehicles were banned from plying in Dhaka from January 1, 2003. Because of prior consultation in preparation for the ban, there was no social unrest even though there were some negative impacts on the livelihood of the people involved with operation of these vehicles. The public response has been overwhelmingly positive, citing much cleaner air along traffic corridors in Dhaka. The weekly average before and after removal of baby taxis showed a 30% drop in average PM_{10} level as shown in the graph below

Source: Khaliquzzaman, 2005

- DTCB is currently preparing Strategic Transport Plan (STP), which will provide a long-term strategic vision for transport system in Dhaka.
- Updating and installation of new traffic signals.
- Construction of road dividers and parking facilities.
- Construction of bypasses and flyovers.
- Decision for amendment of the Motor Vehicles Ordinance, 1983 to provide serious punishment for reckless and drunk driving, illegal parking, using fake driving licenses and other transport related crimes (The Daily Star, 28 March 2005).
- Air Quality Management Program (AQMP) of the DOE is currently conducting a study on policy options to control diesel vehicle PM pollution, and
- Construction of a City Centre in Motijheel area for car parking (see Box-3.3)

Emission from Solid Waste Landfill Site

The solid waste management has become an issue of concern of the general people of Dhaka. In the last ten years, amount of municipal solid waste has increased from 2500

Box 3.2. Recent Policy Decision of The Government

- *Introduction of Compressed Natural Gas (CNG) which has tremendously helped reduce the air pollution of Dhaka city*
- *Introduction of unleaded gasoline from 1st July of 1999*
- *Notification of lubricant standards on 1st January, 2001*
- *Banning of buses older than 20 years and trucks older than 25 years in Bangladesh from 2002*
- *Banning of two-stroke engined three wheeler vehicles from 1st January, 2003*
- *Banning of imported reconditioned cars older than 5 years*
- *Reduction of number of NMVs (Non-Motorized Vehicles) and by restriction of movement of such vehicles within certain areas of the city and during specific periods of the day.*
- *Banning of operation of commercial trucks in Dhaka city during day time (8 am to 10 pm)*

tons/day to 4500 tons/day (Rahman and Islam, 2002). Only 40 – 50% of the total generated waste is disposed to land fill sites and the rest usually remains on the streets, drains and any open-space, spreading bad odor which is a major public nuisance. All abandoned and existing municipal solid waste landfill sites (both temporary and permanent) are open and within a one km of human settlement. These landfill sites emit gases including methane and non-methane organic compounds, for example, benzene, vinyl chloride, and form leachate in the ground. An estimate of solid waste generation is given in Table 3.7.

Huge amount of methane, CO_2 and non-methane organic compounds are being released in the air of the city from landfill sites (Photo 3.2, 3.3). The Government, the DCC and some NGOs particularly Waste Concern are trying to increase recycling and reusing of the existing waste (see section 3.6 for details). However, the DCC needs sanitary landfill sites immediately otherwise the nearby residents may suffer a lot from long-term exposure of non-methane organic compounds viz. benzene.

Emission from Brick Kiln

The brickfields around Dhaka city usually operate for about six months a year. Every year, in the dry season, they burn nearly 2 million tons of coal (The Daily Prothom Alo, 5 March 2004). These brickfields emit huge quantities of air pollutants such as PM, carbon monoxide, sulfur dioxide, nitrogen oxides and of course, carbon dioxide which is a greenhouse gas (Photo 3.4). The impacts for the city environment are the following:

- These brickfields may be responsible for a significant fraction of the PM pollution in the city air nowadays.
- As many of the brickfields are located on the north of the city, the impact of the emission is high during the dry season when air pollution levels are at their worst.
- Reduction in the agricultural production.

The government has recently taken a few measures to control emission from brickfields, but according to the available reports, the current level of compliance is not high. Moreover, rubber (tires), plastics, and wood are widely burnt along with coal, violating the following acts and policy decisions of the government such as :

- Brick Burning Control Act, 1989
- Brick Burning Regulation, 1989
- Stopping issuing license for brick fields
- Formation of local advisory committee about brick field operation
- Relocation of brick fields

Heightened monitoring and enforcement of the existing regulations are essential for reducing emissions from brickfield. The government may try developing alternatives of bricks as building material for construction activities.

Box 3.3 The City Center: The first Designated Car Parking Area in Dhaka City

The first car–parking center is being constructed jointly by the DCC and Orion Group in Motijheel area in Dhaka with private sector investment. The construction started in January 2004 and will be completed by 2007. The centre will be a 37 floor multistoried building of which first the 10 floors will be used for parking cars. These 10 floors will accommodate about 500 cars at the same time. The other floors are for business sectors and there will be a large conference room on the top floor. The area of the centre is about 7 acres. However, this is a great initiative in reduction of traffic congestion in Dhaka city.

Source: The Daily Prothom Alo, 22 May 2005

Industrial Emission

In Dhaka city, most of the industries lack in proper emission and effluent treatment systems. In Hazaribagh, nearly 62 acres of land is occupied by the tannery industries without any treatment plant or protective measures against the corrosion of local buildings and apartments due to toxic emissions (Wahra,

Photo - 3.2. Temporary landfill site at Hazaribagh

Photo - 3.3. Permanent landfill site at Matuail

Table 3.7. Growth of DCC Solid Waste Generation

Year	Solid Waste Generation (Tons/day)	Assumed 50% disposal at landfill sites (Tons/day)
1990	2000	1000
1995	2500	1250
1997	3000	1500
2005	4500*	2250

Source: Rahman and Islam, 2002

** Estimated*

2002). It has been reported several times that many residents and workers are acutely suffering from diseases caused by tannery emissions.

Unregulated emissions from industries in Tejgaon industrial area also contribute to degradation of air quality of the city. However, the extent of the problem has not yet been quantified. The Government has the following policies, acts and guidelines that directly or indirectly address environmentally sound industrial operation.

- Environment Conservation Act, 1995 (amended in 2000 and 2002)
- Environment Court Act, 2000 (amended in 2002)
- Environment Conservation Rules 1997
- EIA guideline for industries, 1997
- Factories Act, 1939
- Environment Policy, 1992

Photo - 3.4. Pollution from Brickfield in the periphery of Dhaka

3.2. Water Resources

Water is one of the main components of environment that has tremendous role in every mode of human life. It is unfortunate that the human activities everywhere in the world are continuously polluting water. Many of the rivers get polluted with industrial effluents, municipal waste, agricultural waste, sewage disposal, etc. However, water resource is

source of major serious concern, considering its contribution to the need of human beings and the natural environment. In fact, Bangladesh is one of those polluted countries, which currently holds 1,176 industries that discharge about 0.4 millions m^3 of untreated waste to the rivers in a day (JICA, 1999). The water quality of many of the rivers, which are close to industrial districts or areas, were tested and found to be beyond the standard limit of water quality parameters.

Water resources of Dhaka city is the most important and is the burning issue in terms of extreme degradation of water quality of the surrounding water bodies, for example, rivers, lakes, ponds and canals. Huge quantities of industrial effluents, solid waste from river-side settlements, petroleum products from ships, launches, cargoes, boats, untreated sewage etc. regularly get dumped into the Buriganga, Balu, Turag and Shitalakshya rivers, which are already severely polluted. The city lakes are not usable for any purpose. In addition, Dhaka is currently facing huge water supply crisis due to the decline in the ground water level in many city areas.

3.2.1. Surface Water Quality

In the last few decades, Dhaka has been greatly changed with rapid urbanization and industrialization, especially through garments manufacturing, establishment of small and large-scale business enterprises, increase of multinational business and trade firms, increasing participation of international organization in the local and national development process etc. Unfortunately, this rapid urbanization process has not taken place in a formal and planned manner. This unplanned approach of development has made this city "a land of unhealthy life". The rivers Buriganga, Balu, Turag and Shitalakshya together receive huge amount of untreated sewage and industrial liquid waste as well as municipal waste regularly through the three major canal systems and direct disposal. Water of the surrounding rivers and lakes has already exceeded the standard limits of many water quality parameters, for example, DO, BOD, COD, pH. The following Tables (3.8-3.11) and Figures (3.2-3.4) indicate deterioration of the river and lake water quality.

Table 3.8 shows that in the dry season of 2003, the Buriganga experienced an average dissolved oxygen measuring less than 2 mg/l whereas the standard limit is 5mg/l (BCAS, 1999). The river Turag also had the same record of having less than the required limit. On the other hand, the concentration of BOD, coliform bacteria and a few other water quality indicators also exceed the standard limits in most of the rivers (Table 3.9). Moreover, the presence of excess amount of concentration of heavy metals including Al, Cd, Cr, Pb, Hg confirms the chemical contamination of water (Table 3.11). All these are occurring possibly due to following reasons.

Lack of Effective Enforcement

Water Resources Planning Organization (WARPO) and the Department of Environment (DOE) are the two key organizations responsible for water resources planning, management, and the analysis of water quality. Four rivers namely the Buriganga, Balu, Turag and Shitalakhya surround Dhaka city. Of them, Buriganga, Balu and Turag are significantly polluted by both land-based (solid waste, agricultural waste, industrial waste, human waste) and water based-activities (dumping of solid waste and wastewater from water transports). The water quality of any of these are so degraded that they are completely unusable for any domestic or even bathing purposes, particularly in the dry season. The water quality parameters, for example, DO, BOD, COD have far exceeded the standard limits that indicate degraded water quality resulting in a) loss of aquatic biodiversity, b) adverse impact on industrial and agricultural users and consumers, and c) increased water borne diseases.

The DOE, IWM (earlier SWMC) and WARPO have monitored surface water level and quality, and found continuous deterioration of water quality of the surrounding rivers and lakes. This indicates insufficient enforcement of relevant policies, acts and guidelines (Box 3.4) though the following organizations are specifically responsible for overall management of water resources.

- Ministry of Water Resources deals with water resources development and planning.
- Bangladesh Water Development Board (BWDB) works with implementation of water related projects.
- Water Resources Planning Organization (WARPO) deals with nation wide water resources planning and management through preparing National Water Management Plan (NWMP), National Water Resources Database, and scrutinizing and clearing water related projects.
- Department of Environment (DOE) holds the responsibility of environmental management and control of water resources.

Table 3.8. Average concentration of Dissolved Oxygen (DO) of different rivers in different seasons from 2001 to 2003

Name of River	DO											
	Pre-01	Mon-01	Post-01	Dry-01	Pre-02	Mon-02	Post-02	Dry-02	Pre-03	Mon-03	Post-03	Dry-03
Buriganga Hazaribag tannery main drain	2.7	6.5	6.4	1.7	2.7	5.8	6.0	2.7	3.6	6.7	3.4	1.1
Sadarghat near BI-WTA launch terminal	5.6	7.0	6.2	1.9	3.2	6.3	6.6	2.9	5.0	7.0	4.9	2.7
Shitalakhya Near ACI factory	6.3	6.6	6.9	5.3	7.0	7.0	7.1	6.9	6.1	7.4	6.3	5.9
St. Demra Ghat	6.8	6.6	6.1	6.8	6.8	6.9	6.8	6.9	6.1	7.4	6.0	6.1
Balu Waste discharge point of Bengali Indico Ltd. at Tongi	-	6.1	6.0	6.1	2.6	6.0	6.4	4.4	5.4	7.3	4.2	6.0

Source: Department of Environment, 2004; EQS for DO: 5 or above

Table 3.9. Average concentration of Biological Oxygen Demand (BOD) of different rivers in different seasons from 2001 to 1003

Name of River	BOD											
	Pre-01	Mon-01	Post-01	Dry-01	Pre-02	Mon-02	Post-02	Dry-02	Pre-03	Mon-03	Post-03	Dry-03
Buriganga Hazaribag tannery main drain	16.0	3.9	3.1	28.0	11.0	2.6	2.9	9.5	15.3	3.7	10.0	14.7
Sadarghat near BIWTA launch terminal	3.3	4.4	3.5	14.0	9.9	3.4	3.3	8.3	6.8	3.9	5.4	8.0
Shitalakhya Near ACI factory	3.8	3.1	2.8	3.7	3.9	3.5	3.7	2.8	3.1	3.8	3.2	2.8
Demra Ghat	3.4	2.6	3.8	2.9	3.6	3.5	3.3	3.2	2.9	3.9	3.0	3.1
Balu Waste discharge point of Bengali Indico Ltd. at Tongi	-	3.8	3.6	3.2	9.0	3.6	3.5	6.7	2.4	3.8	9.0	2.8

Source: Department of Environment, 2004 ; EQS for BOD: 10 or less

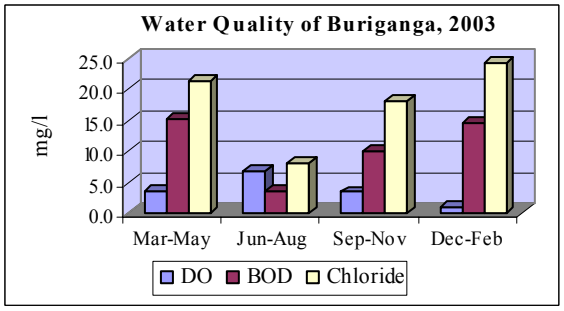
Table 3.10. Average concentration of pH in different rivers in different seasons from 2001 to 2003

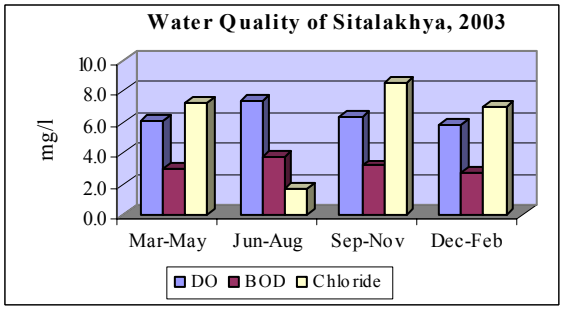
Name of River	pH											
	Pre-01	Mon-01	Post-01	Dry-01	Pre-02	Mon-02	Post-02	Dry-02	Pre-03	Mon-03	Post-03	Dry-03
Buriganga Hazaribag tannery main drain	7.1	7.3	7.2	7.4	7.3	7.2	7.3	7.2	7.3	7.2	7.2	7.3
Sadarghat near BIWTA launch terminal	7.1	7.0	7.2	7.3	7.2	7.0	7.1	7.2	7.2	6.9	6.9	7.1
Shitalakhya Near ACI factory	7.3	7.2	7.1	7.4	6.9	6.9	7.0	7.0	7.1	6.9	7.1	7.1
Demra Ghat	6.8	6.9	6.9	7.1	7.1	6.9	6.9	7.3	7.1	6.8	6.9	7.2
Balu Waste discharge point of Bengali Indico Ltd. at Tongi	-	7.2	7.2	7.2	6.9	6.9	7.1	7.1	7.2	6.9	7.2	7.2

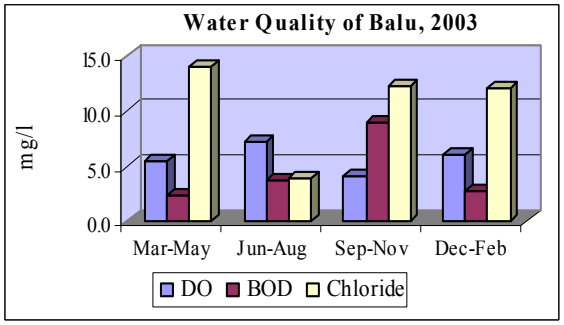
Source: Department of Environment, 2004 ; EQS for pH: 6.5-8.5

Notes:
Pre monsoon = March, April, May
Monsoon = June, July, August
Post monsoon = September, October, November
Dry season = December, January, February

All units in mg/l except the following:
Five days BOD at 20^0C







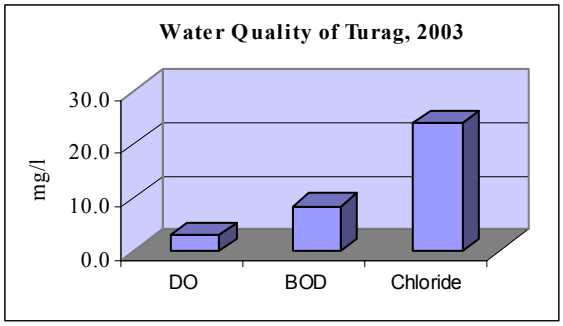


Figure - 3.2. Water quality of surrounding rivers (A-D)

Source: DOE, 2004

Notes:
Pre monsoon = March, April, May
Monsoon = June, July, August
Post monsoon = September, October, November
Dry season = December, January, February

Notes:
All units in mg/l except the following
1. Five days BOD at 20^0C

Table 3.11. Heavy metal concentration in river water of Dhaka city (Shamsuzzoha, 2002)

Sample ID	Concentration in mg/l						
	Al	Cd	Cr	Pb	Hg	Se	Zn
Buriganga River Friendship Bridge	3.27	0.014	0.036	ND	0.0021	0.001	0.56
Turag River: Amin Bazar	11.884	0.018	0.11	0.394	0.0058	0.0002	1.002
Buriganga River Chandni Ghat	5.396	0.006	0.006	0.25	0.0016	ND	0.984
Lakhya River: Sayedabad WTP Intake pt	2.952	0.006	0.028	0.074	0.0032	0.0005	0.246
Balu River Zirani Khal	2.1166	0.006	0.0224	ND	0.0010	ND	1.122
Recommended value For Drinking water*	0.2	0.005	0.05	0.05	0.001	0.01	5.0

ND: Not detectable

* Environmental Quality Standards (E Q S) for Bangladesh; Department of Environment; July 1991.

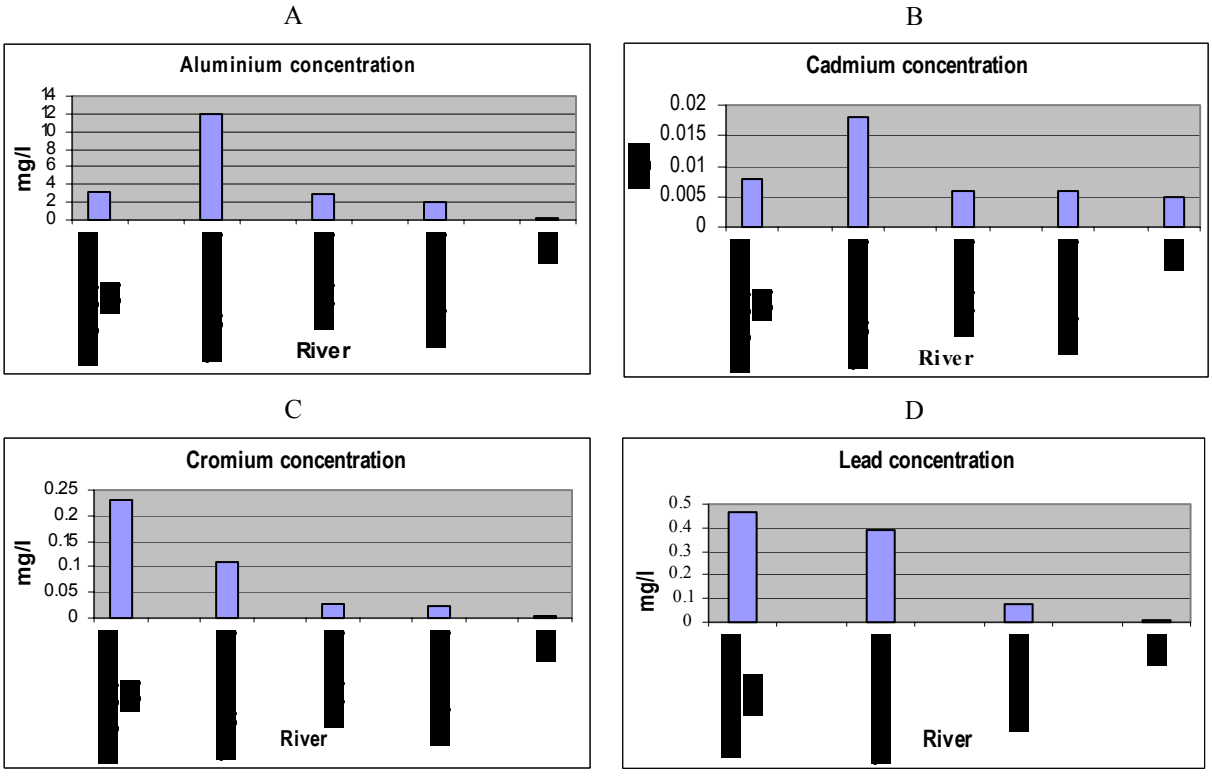


Figure - 3.3. Metal concentration (A-E) in different rivers (at specific location) in April 3, 1997

Some other government agencies and NGOs are also actors in the water sector, viz. Ministry of Environment and Forest, Ministry of Agriculture, Ministry of Fisheries and Livestock, Bangladesh Inland Water Transport Authority (BIWTA), Department of Public Health and Engineering (DPHE), Local Government Engineering Department (LGED), International Union for Conservation of Nature (IUCN), International Center for Living and Aquatic Resources Management (ICLARM), Bangladesh Centre for Advanced Studies (BCAS), Institute of Water Modeling (IWM), Bangladesh Environmental Lawyers Association (BELA), and Centre for Environment and Geographic Information System (CEGIS). However, proper management of water resources recognizes many limitations, some of which are as follows:

- Inadequate fund
- Manpower shortage
- Technical deficiency (lack of equipment and logistic support)
- Professional negligence
- Lack of transparency and accountability

The government must take an effective surface water management initiative for Dhaka city as a top priority issue. Continuation of the current situation will spread the pollution and service providing authority will find no source to collect water for household supply in the near future. The key reasons are:

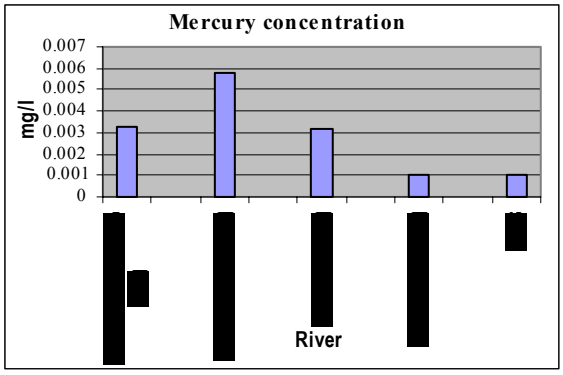


Figure - 3.4. Concentration of mercury in Different Rivers

Untreated Sewage Disposal

As mentioned in section 8, the existing sewage treatment plant treats only 40,000 to 50,000 m^3 of sewage while the city generates about 1.3 million m^3. Most of the rest directly or indirectly reach the surrounding rivers (see section 3.7 for details).

Municipal waste disposal into city water bodies

Dhaka city has a population of over 6 million that regularly generate about 4,000 tons of solid waste, of which less than 50% is disposed in the landfill site and a significant part of the remaining waste goes into the water bodies (see photo 3.6 and section 3.6 for details).

Table 3.12. Concentration of water quality indicators of lake water of Dhaka city (November, 2001)

Name of the Lake	pH	BOD	DO	TS	Coli forms
Dhanmondi lake near Russell Square.	6.95	1.9	6.1	168	600
Gulshan-Baridhara lake , Road No.11	7.1	35	0.5	302	1200
Sitadel Lake East Side	6.91	2.6	6.6	92	500
Ramna Lake Beside Ramna Ch. Restau-rant	6.52	25	1.3	87	700
Crescent Lake East side	5.9	2.1	8.3	98	900
EQS	6.5-8.5	3 or less	5 or above		200 or less

Source: DOE in Majed and Rahman, 2002

Note: Environmental Quality Standard (EQS) of lake water (used as recreation purposes)
All units in mg/l accept the following:
Five days BOD at 20^0C
Coli-Colonies/100 ml/ (24 hrs incubation at 35^0C)

Disposal of waste, wastewater and petroleum products from water transport vehicles

Most of the districts of Bangladesh have direct water transport communication with Dhaka through the BIWTA terminal at Sadarghat. Everyday, a large number of launches, steamers, cargo and country boats and other vehicles arrive and leave from and for other districts with passengers and products. This route is used to transport different types of petroleum or chemical products (paints, mosquito coil, spray, grease, agro-chemicals viz. pesticides, fertilizers) from Dhaka to different districts of the country (see photo 3.5). During loading and unloading, the cargo vessels containing these materials get damaged and drip into the river. Many people visit this terminal daily and they also dump wastes into the river. All launches, steamers, boats, trawlers use oil or petroleum products to run the vessels or for transportation elsewhere. These petroleum products and wastewater are also regularly disposed of into the river. The government must take necessary action on an emergency basis to monitor these activities in order to save the surface water of Dhaka city. Frequent environmental audit may reduce pollution sources.

Box 3.4

Water Related Policies and Acts of Bangladesh

- *National Water Management Plan, 2004*
- *Bangladesh Water Development Board Act 2000*
- *Urban Water Body Protection Law 2001.*
- *Irrigation Water Rate Ordinance 1983*
- *National Water Policy, 1999*
- *Water Resources Planning Act 1992*

Relevant Policies and Acts

- *National Environment Policy 1992*
- *Environment Conservation Act 1995*
- *Environment Conservation Rules 1997*
- *Environment Court Act 2000*
- *Wetland Protection Act 2000*
- *National Policy for Safe Water Supply and Sanitation 1998*
- *Groundwater Management Ordinance 1985*
- *Water Supply and Sewerage Authority Act 1996*
- *National Forestry Policy 1994*
- *National Fisheries Policy 1998*
- *National Agriculture Policy 1999*
- *Industrial Policy 1999.*
- *EIA Guidelines for Industries 1997*
- *Dhaka Metropolitan Development Plan, 1997*
- *Municipal Ordinance, 1993*

Unplanned development and encroachment of rivers

Dhaka has rapidly developed with a large number of industrial and commercial establishments, formal settlements, roads and highways and growth of real estates. Most of these development activities were carried out in an unplanned way and many of them were established illegally. According to a survey of DOE, there are 244 establishments, which include 35 slums, 20 saw mills, 16 dock yards, 11 fruit and vegetable godowns, 7 mosques and madrasas, 4 manufacturing industries and 20 textile mills encroaching and occupying about 50 acres of Buriganga river (Hasan, 2004). The same practices are continuing with all the lakes of Dhaka city. Many small-scale business enterprises, slums and houses are built by encroaching on Gulshan and Banani Lakes.

It is also assumed that the disappearance of small water bodies (e.g. ponds, ditches etc) in the city may be due to encroachment and illegal filling up of wetlands by the local muscle power. In 1997, the DoE formed a committee headed by the Minister of Environment and Forests, who is in charge of the overall action plan to implement the "Save Buriganga" programme. In 1998, 244 illegal establishments were found and the Bangladesh Inland Water Transport Authority (BIWTA) demolished nearly 200 of them, though within a couple of days, a number of illegal structures were erected again (Hasan, 2004). BIWTA is preparing a proposal to protect the Buriganga, which includes the beautification of Sadarghat terminal and construction of a secondary port at Ali Bahar Char near Pagla. However,

Unplanned development and encroachment of river and wetlands have reduced river boundary, destroyed natural flow of river, adversely impacted aquatic ecosystem, and reduced storage capacity of natural system.

considering the severe degradation of the Buriganga, "Save Buriganga Movement" was launched to mobilize mass support in a bid to save the river. Recently, a sub-committee of BAPA has launched demonstrations against pollution and illegal encroachment in the Gulshan-Baridhara Lake, Ashulia water bodies, other rivers surrounding the city, viz. Turag, Shitalakshya, Balu and against occupying and filling-up of other water bodies in the city. The Dhanmondi lake improvement project has already been implemented which contributed to its beautification a little, but the quality of water may still be poor. The incidences of pollution will increase if we fail to enforce the following plan and relevant policy and acts.

- First Dhaka Master Plan, 1959
- Dhaka Metropolitan Development Plan, 1997

Agricultural activities and unsanitary practices

Nearly 46 percent of the total land area of Dhaka city is used for agricultural mainly horticulture practices. Many farmers use pesticides and fertilizers in their agricultural fields. Some of the pesticides may remain active for a considerable period and do not degrade easily, which in turn flow into the water bodies during the rainy season. It is some time reported that many farmers still use banned pesticides to get more agricultural yields without caring for the consequences. In fact, country as whole has very little enforcement in controlling the use of harmful pesticides and inorganic fertilizers.

Photo - 3.5. Petroleum products are transported through river channel

Photo - 3.6. Dumping of municipal solid waste in Gulshan Lake

Many people, especially those living in slums and squatters, defecate in the water bodies (photo 3.8), which are additional factors of intensifying microbial contamination of surface water. A large number of latrines are built for the workers of industries and commercial centers on the riverbanks that are also used by the public and pavement dwellers. Agricultural and other relevant policies should be enforced and implemented properly; otherwise, the environmental and health consequences of using harmful pesticides will exacerbate further. The government and the NGOs should also take initiatives to enhance access to sanitary public latrines within the city area.

3.2.2. Threat to Groundwater Resources

Besides the deterioration of surface water quality, ground water, the most dependable natural water resource for drinking water of Dhaka city, is also under threat due to a) over exploitation by 1083 DTWs (WASA - 395 and Private - 688) (WASA, 2004), and b) low rate of recharge.

The unplanned urbanization (construction) has created huge impervious areas in the city that does not allow rainwater to be absorbed into the soil. Also, the city does not have enough open spaces for rainwater to accumulate. These two factors together threaten the ground water resources, since recharge is not occurring as required. This may be the reason for the decline in GW level. Some of the areas like Mohammadpur, Mirpur, Dhaka Cantonment and Dhanmondi have a record of rapid

declination. Table 3.13 shows the continuous decline of ground water level in Dhaka city.

Moreover, WASA recently found high concentrations of E. coli in the ground water of old town of Dhaka. They have also tested the supply water and found impurities in one of two samples (WASA, 2003). According to a recent joint study of the DoE and WASA, eleven pumping stations out of thirty-two showed both chemical and microbial contamination of groundwater (The Daily Star, 17 January 2005). The identified contaminants were residual chlorine, coliform and faecal coliform. The government should take it as a major health concern and act accordingly.

Table 3.13. Depletion of ground water in different years

Year	Depletion (metre)
1996	26.6
1997	28.15
1998	30.45
1999	31.86
2000	34.18
2001	37.78
2002	41.87
2003	46.24

Source: The Daily Star, March 10, 2004

3.2.3. Inadequate Water Supply

The excessive population growth with uncontrolled migration and natural increase together has created extreme demand on the utility services of the city, especially, the supply of water. In a recent report of WASA, the total supply water was 1,376 MLDs, of which about 1,148 million liters were drawn from groundwater source through 395 deep tube wells in Dhaka city. The rest of the water comes from Saidabad and Dhaka water treatment plants (WASA, 2004). The city gets about 81% of the total water from ground water sources (WASA, 2004). The report also shows that in the last five years, the demand for supply water has increased to 2000 million liters in 2003 from about 1345 million in 1998, when the number of deep tube wells of WASA was only 234 (DOE and IUCN, 2000). This

Photo - 3.7. Encroachment of Buriganga River for settlement

Appropriate technical interventions, institutional capacity, suitable economic instruments and political will are identified as strategy to face environmental issues and challenges of Dhaka City.

demand increases during summer, when the supply decreases. This causes various problems for the city people which are as follows:

- Severe water scarcity, especially in poor households.
- Worsened improper sanitation.
- People suffer from water related and water borne diseases in larger numbers.

WASA can supply water to only 55% to 60% of city people and the rest gets water from privately owned DTWs. According to WASA, the number of these privately owned DTWs in Dhaka city is 688. In fact, rapid real estate development, industrial establishment and informal settlements have created huge demand, which is met through legal and illegal water supply connections. According to the managing director of WASA, there are about 50,000 illegal connections in Dhaka (The Daily Star, January 25, 2004). He added that Mirpur and Postagola areas have maximum illegal connections. Many of the legal and illegal connections may be causing huge misuse of water, which also creates supply crisis. Government should take initiative to reduce illegal connections and system loss, which is happening mainly due to lack of transparency and accountability, monitoring and professional sincerity.

Dustho Shastho Kendro (DSK) and Water Aid have very good contribution in supplying water to poor households of the city. WASA should

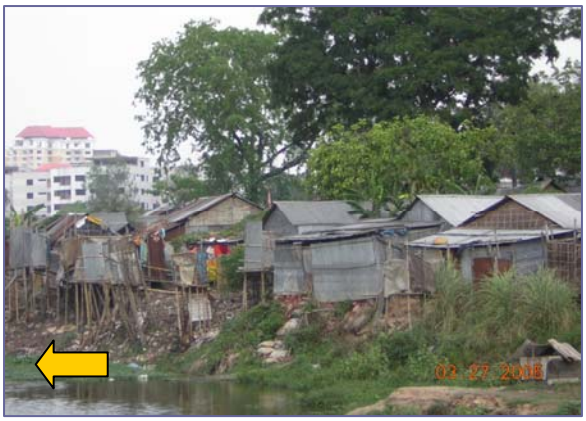


Photo - 3.8. Hanging toilets of slums in Gulshan area

strictly enforce the sustainable use of water, otherwise there would be a severe water crisis in the near future due to present over exploitation of water and increasing surface water pollution. The Table 3.14 and Figure 3.5 show the recent demand and deficiency of supply water in Dhaka city.

The DEP (Dhaka Environment Programme) strategy of the Department of Environment has identified a number of environmental issues within 1,696 km^2 of Dhaka City. This strategy has identified four driving mechanisms to face the identified environmental issues and challenges. These are appropriate technical interventions, institutional capacity, suitable economic instruments and political will with a long-term vision.

3.3 Land

Land is another key component of the environment, which has supported human existence for thousands of years with its natural quality and quantity. But the land use practices of the last few decades have caused serious degradation of its natural value in many parts of the world, especially in Asia and the Pacific. Asia and the Pacific covers around 23 percent of the total land of the earth, of which a large part is facing critical land degradation and soil contamination. The major driving forces are high population growth and density, poor land management practices and inequities in access to land and resources (UNEP, 2002).

Bangladesh has the highest record of land degradation and soil contamination, mainly caused by unwise use of agricultural inputs and inefficient management. But in Dhaka, huge inequity in land use practices and patterns, excessive pressures on land, uncontrolled industrial management as well as agricultural degrade and contaminate the city lands. Most of the city lands receive huge amount of pesticides and polluted water from the surrounding rivers during cultivation. The city also lacks proper solid waste management systems. Industrial discharges, especially from the tanneries in Hazaribagh are severely polluting large areas of soil surface with different toxic chemicals. In fact, rapid urbanization, industrial development, increased economic activities toward development with participation of national and international parties also remain responsible for land and soil degradation.

3.3.1. State of Land Resources

Excessive population growth with formal and informal economic activities resulted in the growth of numerous informal and formal housing settlements, mushrooming shopping complexes, huge number of place of worships (e.g. mosques), retail markets, roads construction etc. To support the booming population and increasing economic activities, it is necessary to carry out development and establishment processes in a planned manner. The government has actually failed to support the population due to constraints, especially financial and administrative. In addition, none of the government utility and security service providers could meet the demand of the city dwellers satisfactorily or exercise proper control over its services to the city dwellers. As a result, private and informal housings were developed without any regard for land use plan or policy. Lack of enforcement in some ways also contributed to the establishment of private settlements in this manner. Consequently, most of the areas of the city have become congested due to lack of open space and many areas covered with concrete structures have decreased the area of infiltration of rainwater into the soil.

Table 3.14. Dhaka city water supply demand and deficiency (WASA, 2003, 2004)

Year	Deep tube wells (Nos.)	Water Supply Coverage (%)	Water Demand (MLD)	Water Production (MLD)	Deficiency (MLD)
1998	234	42	1345	868	-477
2003	381	55	2000	1147	-853
2004	395	55	2050 (approx)	1148	-902

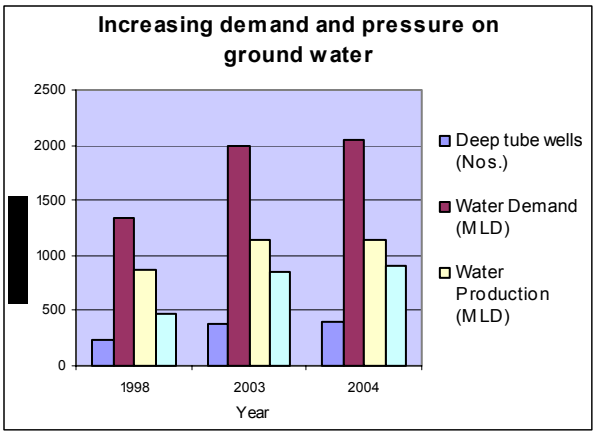


Figure - 3.5. Dhaka city water supply demand and pressure on ground water

Improper city land use practices

From the beginning of the history of Dhaka to the present day, the development of some areas only went through a planned way. An attempt was made by the East Pakistan Government to establish a high class residential area in Dhanmondi, when the other contemporary sophisticated areas like Wari, Ramna, and Purana Paltan were spoiled by excessive development of low rent houses, small business enterprises, educational institutions, coaching centers, health care centers etc. The same thing happened to Gulshan, Banani, Baridhara, and Uttara, with the extension of Mohakhali, Tejgaon, Badda and other adjoining areas. The first Master Plan of Dhaka suggested that at least 480 hectors of open space would be kept in the city for better condition of the city environment. According to the then Dhaka Improvement Trust (DIT), the open space had decreased to 318 hectors in 1978 and recently the concerned people think that the city may contain less than 60 hectors of open space now (The Daily Prothom Alo, 6 March 2005).

In fact, none of the development activities properly follow any plan or policy of land use, which causes the following problems-

- Reduced open space
- Reduced vegetation cover
- Loss of carrying capacity
- Loses dignity of residential area
- Threatens environmental sustainability
- Increased health risk

These are mainly happening due to excessive pressure on and access to city land with rapid development and establishment of a) industry and factory, b) road infrastructure, c) health and educational infrastructure, d) commercial establishments, e) real estate, and f) formal and informal settlements.

This rapid development also recognizes the following major gaps or lacks in the development process.

- Enforcement of Dhaka Master Plan, 1959 or Dhaka Metropolitan Development Plan, 1997
- Proper utilization of or adherence to the Bangladesh National Building Code, 1996
- Awareness of land use practices
- Transparency and accountability
- Professional ethics
- Technical expertise

The government had prepared a Master Plan in 1959 considering the land use practices within the greater metropolitan area of Dhaka city and handed over to the then Dhaka Improvement Trust (DIT) to implement the recommendations (Islam, 1996). In 1987, the government further realized the importance of Dhaka city land use practices and upgraded DIT to RAJUK (the

Box 3.5. Land Use Violation!!

A survey conducted by Dhanmondi Paribesh Unnayan Jote found about 142 educational institutions in the total 296 commercial organizations. These commercial organizations are located in almost every road of this designated residential area though only the plots adjacent to Mirpur Road, Satmasjid Road, Road No 27 and Road No 2 were permitted to be converted for commercial purposes.

Source: The Daily Star, 6 March 2005

capital development authority) giving it more responsibilities regarding city development and improvement. Later, within five years of RAJUK's establishment, they had the opportunity to prepare a new Master Plan for the capital in 1992, which included a five year duration for planning and implementation. One of the major recommendations of the DMDP was not to establish multistoried shopping complexes in the city area, particularly the northeastern zone of the city, but this recommendation is not being followed. The Government is required to enforce the existing plan, policy and regulations, otherwise adverse impacts on the environment will only deepen further.

Mixed Land Use Practices

Dhaka has been experiencing huge migration and natural growth of population every year due to many push and pull factors. This huge population growth has increased the basic demand for settlements and utility services. These demands turn into establishment of both formal and informal settlements (slums and squatters) rapidly all around the city. Most of the designated residential areas including Dhanmondi, Gulshan, Baridhara, Uttara, and Banani are also more or less occupied by excess number of schools, colleges, universities, coaching centers, industries and factories particularly garments, health care centers (hospitals, clinics, diagnostic centers), mushrooming shopping malls and small-scale business enterprises (see Box 3.5). The first designated residential area, Dhanmondi, became a semi-commercial area with above settlements. The same situation is prevailing in the old city. It is very difficult now to identify whether the old city currently contains any residential area, though once major parts of it were high-class residential areas. The old city is now severely crowded and compacted with population and housing respectively. In addition, a large number of textile and dyeing industries, washing plants, garment factories also occupy the old city. This mixed land use practice is one of the causes of the following problems.

- Degraded living standards and quality of housing
- Pollution of surrounding air and surface water due to industrial operations
- Damage to residential buildings
- Noise pollution
- Traffic congestion that may degrade air quality of the residential area.

Photo - 3.9. Encroachment of Banani Lake by informal settlements

Photo - 3.10. Encroachment of Gulshan lake by formal settlement

Box 3.6. Water Logging: An Emerging Concern of City Dwellers

Heavy rainfall of even small duration causes water logging in most of the areas of Dhaka city. This water logging is primarily due to inadequate storm water sewer infrastructure or absence of any sewer system at all. Furthermore, if there exists any storm sewer system, then it will be found less effective being partly or fully filled with sediment or will be found inadequate in size or laid in improper grade. All these causes make the system disabled to drain out the storm water in time. Covering the storm water inlets by road carpeting materials or other construction materials and improper maintenance of inlets of storm sewer aggravates the scale of this problem. Increase of concrete/metal surface day by day is also contributing in increasing the volume of surface runoff which is worsening the water logging phenomenon.

Lack of compliance with existing policies and plans also causing the following problems.

- Reduced open space
- Reduced vegetation cover
- Loss of carrying capacity
- Loses dignity of residential area
- Threatens environmental sustainability
- Increased health risk

The government should be more active regarding city land management, otherwise this will continue reducing open space, increase unplanned urbanization and therefore, threaten sustainable development.

Encroachment of rivers, canals, wetlands, forests and agricultural land for settlements

The need for settlements for the ever increasing population and economic activities in the city influenced deforestation, encroachment on wetlands and agricultural land all around the city. Most of the lakes of Dhaka city are now more or less occupied due to both formal and informal settlements (see photo 3.9 and 3.10). Local influential people have also been occupying huge quantities of land reclaimed from lakes, canals and rivers. In fact, the wetland encroachment in Dhaka city has become a regular practice with influential people's demand for land, which is threatening the wetland ecosystem and biodiversity. According to WASA, only 26 canals out of the former 43 are recognizable now in Dhaka city and the rest are somehow encroached to an extent that severely decreased the drainage capacity of the city (The Daily Star, 30 March 2005). The city is also expanding towards the north and the east, occupying agricultural lands. All these create the following difficulties.

- Water logging (See Box 3.6) during rainy season
- Reduction of agricultural production
- Threat to wetland ecosystem
- Reduced vegetation coverage
- Reduce recreation facilities

Recently, the government has decided to get rid of all sorts of encroachment on the water bodies to improve the city drainage situation. Already, the government has demolished most of the illegal structures on the Kalyanpur canal and this drive will continue in order to recover 7 more canals in the city (The Daily Star and The Daily Jugantar, 30 March 2005). The government may also require enforcement of the following acts and policies to reduce encroachment of above areas.

- Wetland Protection Act 2000
- National Agriculture Policy 1999
- Environment Conservation Act 1995
- Environment Conservation Rules 1997

Photo - 3.11. Untreated tannery waste dumped on open land surface in Hazaribagh industrial area

Table 3.15. Concentration of heavy metals in the soil of industrial areas of Dhaka city

Industrial Area	Heavy Metals			
	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)	Cr (mg/kg)
Hazaribagh	1.8	99	477	11,000
Tejgaon	2.6	136	685	--
Standard Limit *	1	50	200	100

Source: Kashem & Singh, 1999; Wien and Jordan, 2000 European Environmental Agency*

3.3.2. Soil Pollution

Besides the conversion of land with rapid development and unplanned settlement growth, the city also faces a severe soil contamination in the industrial areas especially in Hazaribagh and Tejgaon. Recently, studies were carried out on the soil quality of different industrial areas of Dhaka city by the Norway Agricultural University (1999) and the Austrian Research Center (2000). Table 3.15 shows their findings.

The analysis of the soil of Tejgaon and Hazaribagh industrial area brings to light severe contamination with heavy metals exceeding the environmental quality standards. Mr. Jordan of the Austrian Research Centre also found the soil of Tejgaon to be acidic with pH 5.7. Moreover, improper solid waste management also causes soil pollution through formation of leachate.

Several studies were conducted in different years to determine soil quality by testing the leachate of landfill sites. Table 3.16 shows the leachate characteristics.

Photo - 3.12. Political meeting at Jatrabari using loudspeakers

The leachates of abandoned and existing landfill sites were also tested by the Bangladesh University of Engineering and Technology (BUET). The Gabtoli site showed pollution with presence of faecal coliform bacteria and an excess of BOD and COD (Bhuiyan, 1999).

The government does not yet have enough effective initiative for monitoring land and soil quality of the city. However, there is a decision to relocate the tannery industries from Hazaribagh, an area that is now severely polluted with chromium. All the industrial areas should be monitored frequently with enforcement of relevant acts, policies and guidelines.

3.4 Noise

Level of noise in Dhaka city is now a major concern for the general people because it has

Table 3.16. Characteristics of Leachate in Landfill Sites of Dhaka city

Parameters	Unit	Range of value found in waste disposal sites	Typical value
pH		4.5-6.0	4.75
Suspended solids	mg/L	3000-14000	10000
Chlorides	mg/L	5000-13000	1400
Phosphate	mg/L	0-15	5
Chemical Oxygen demand	mg/L	5000-17000	14000
Biochemical Oxygen demand	mg/L	5000-15000	9000

Source: Nury, 1998 in Bhjuiyan and others, 2002

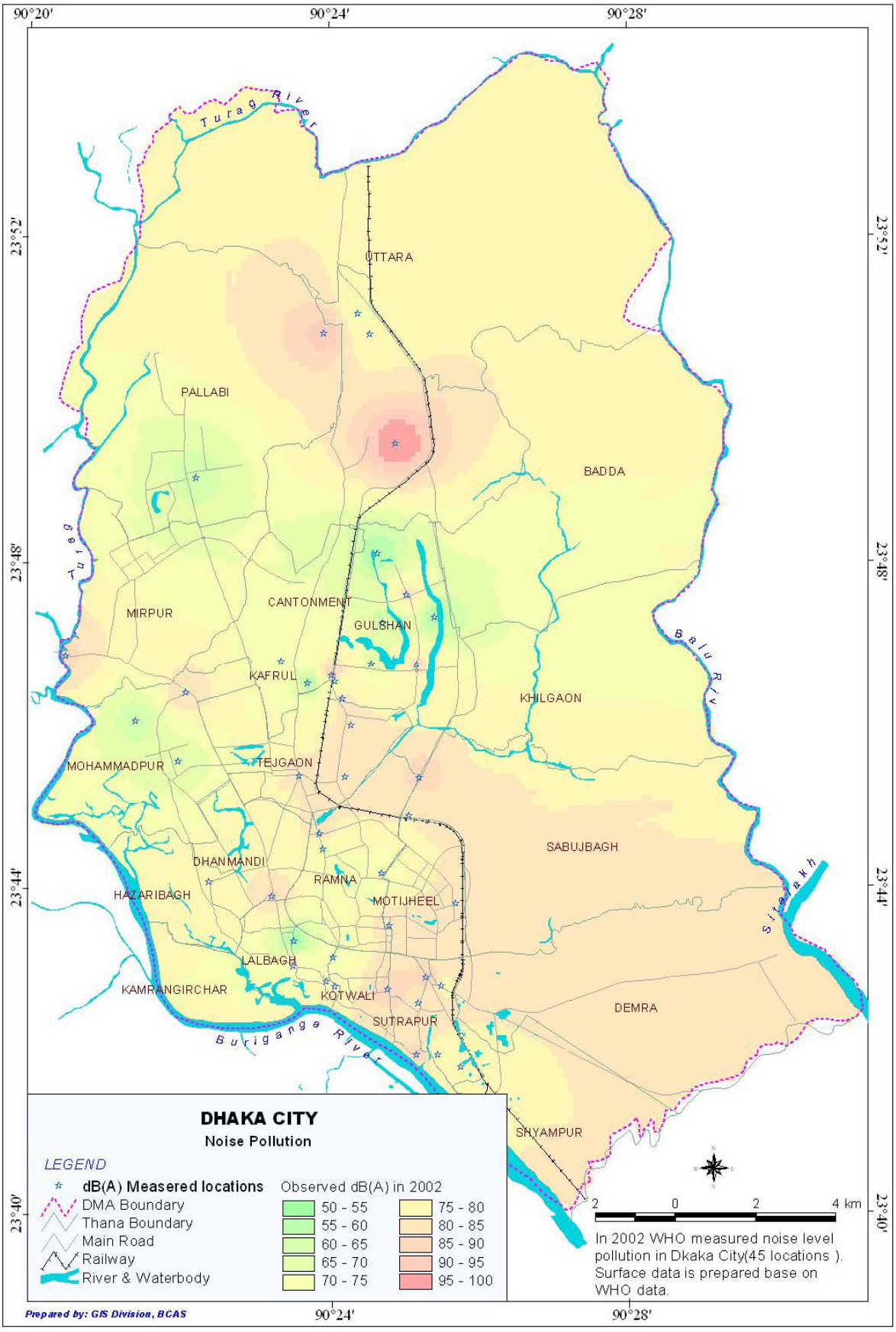


Figure - 3.6. Noise Pollution of Dhaka City

Table 3.17. Noise Level in Silent Zone of Dhaka City

Name of Areas	1999 (dB)	2002 (dB)
I.C.D.D.R.B Hospital	76.5	65.0
Dhaka Medical College Hospital	70.0	70.0
Kakrail Mosque	70.0	70.0
Bangabandhu Sheikh Mujibur Rahman Medical University	68.9	69.0
Shaheen School	67.6	58.0
Titumir College	66.8	66.8
Temple and Church	65.5	85.3
I.P.H. Mosque	60.0	55.0
Dhakeswari Mandir at Bakshi Bazar	53.0	53.0
NIPSOM	50.0	57.0
Standard Limit for Bangladesh	50	50

Source: WHO, 2002

Table 3.18. Noise Level in Residential Areas of Dhaka City

Name of Areas	1999 (dB)	2002 (dB)
Mirpur	79.4	63.0
Shakaripatti	75.5	75.6
Dhaka Cantonment	74.4	73.0
Dhanmondi	67.0	65.0
Banani	61.4	61.4
Mohammadpur	61.0	61.0
Gulshan	56.6	55.0
Standard Limit for Bangladesh	55	55

Source: WHO, 2002

Table 3.19. Noise level in Mixed Areas of Dhaka city

Name of Areas	1999 (dB)	2002 (dB)
Mouchak Round	92.6	80.0
English Road	90.0	90.0
Dhaka Judge's Court	83.7	83.7
Chawk Bazar	77.8	79.0
Shakaripatti	77.5	75.5
Standard Limit for Bangladesh	60	60

Source: WHO, 2002

Table 3.20. Noise level in Commercial Areas of Dhaka City

Name of Areas	1999 (dB)	2002 (dB)
Framgate	90.0	81.0
Rajuk Avenue	87.8	87.8
New market	86.4	86.3
Gulshan	86.3	82.0
Motijheel	82.0	83.0
Standard Limit for Bangladesh	70	70

Source: WHO, 2002

Table 3.21. Noise level in Industrial Areas of Dhaka City

Name of Areas	1999 (dB)	2002 (dB)
Inside of Nabisco, Tejgaon	89.0	85.0
Tejgaon	87.0	84.0
Hazaribagh	80.8	80.0
Standard Limit for Bangladesh	75	75

Source: WHO, 2002

exceeded the tolerance level. According to a recent study conducted by WHO at 45 locations of Dhaka city, most of the traffic points and many of the industrial, residential, commercial, silent and mixed areas are suffering noises exceeding the standard limits of Bangladesh. WHO found noise levels of 70 dB in Dhaka Medical College, 75 dB in Shakhari Patti, 90 dB in English Road, 87.8 dB in Rajuk avenue and 85 dB in Tejgaon, though the standard limit for those area are 50, 55, 60, 70 and 75 dB respectively. WHO has also identified several areas as severe red, moderate red, mild red and green zones in terms of noise pollution in Dhaka city (Figure 3.6). These are mainly due to vehicular horns and movement, loudspeakers from processions and meetings, high volume of audio players from roadside small business enterprises and others (see photo 3.13). Another study was conducted in 1999 in the same areas, which had also showed almost similar findings. The noise scenarios of Dhaka city, in fact, show an extreme threat to human health, especially for elderly people and

Table 3.22. Average noise level for different land use categories in Dhaka City in 1999 and 2002

Location	1999 (dB)	2002 (dB)	Standard Limit for Bangladesh (dB) Day-Time
Silent Area	64.8	64.9	50
Residential Area	70.5	64.9	55
Mix Area	84.3	81.6	60
Commercial Area	86.5	84.0	70
Industrial Area	85.6	83.0	75

Source: WHO, 2002

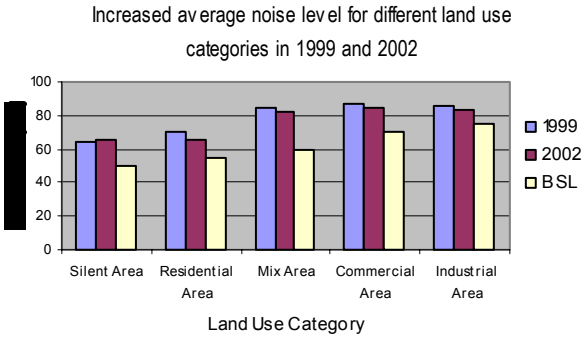


Figure - 3.7. Increased noise level in different areas of Dhaka city

children. Moreover, the traffic personnel, rickshaw pullers, open vehicle drivers, road side workers, small scale business enterprise workers etc are exposed for long-term noise pollution which might cause severe mental and physical health problems. Details of the noise level of different zones of Dhaka city are shown in Table 3.17 to 3.22 and Figure 3.7 indicates the exceeding limits of sound.

However, an average sound level was determined in all the above findings, which is represented in Table 3.22.

Nearly 0.3 million of motor vehicles and over 0.4 millions of non-motorized vehicles are plying the roads and streets of the city. These vehicles on limited road surface cause extreme traffic confesting, especially near the bus terminals and bus stops within the city. Many of the major roads, lanes and by-lanes remain damaged all year around, which causes collision of vehicles and high levels of noise. Herein follows are the details of noise sources of Dhaka:

3.4.1 Vehicular horns

Due to traffic jams on the roads of Dhaka city, most of the vehicles use their horn constantly, which is extremely harmful to human health, especially for children. The World Health Organization (WHO) opines that 60 decibels of sound can make a person deaf (The Daily Bangladesh Observer, 9 April, 2004). The noise level of Dhaka is more or the city have sound level more than the noise quality standard.

The WHO study already identified eight areas in Dhaka city as severe red zones and ten areas as moderate red zone for noise pollution of which Mahakhali, Gabtoli, and Sayedabad bus terminals are on the top for extreme noise pollution. Moreover, due to lack of awareness and inefficiency in driving, many drivers use the horn unnecessarily that increases sound level in the proximity. The practical situation is very severe in the mornings near any primary of secondary school. The drivers constantly blow their horns, which directly expose the students to higher level of sound. Many vehicles with very old engines ply on the city street that sometimes create more noise than the horns. However, proper enforcement of the following policies, acts and guidelines may able to address the noise hazards in the city.

Environment Policy 1992

Environment Conservation Act 1995

Environment Conservation Rules 1997

EIA guidelines for industries to control the noise pollution of the city

Besides the above mentioned policies, acts and rules, recently the government has taken some action to control noise level in the city**.** Some of these initiatives are as follows.

- Formulation of Noise Control Rules, 2004.
- Banning vehicular hydraulic horns.

- Monitoring mechanism at the main traffic points to determine whether the vehicles follow the orders or not.
- Removal of 4000 nos. of hydraulic horns by the DMP from the vehicles plying on the city street (Hasan, 2003).
- Tejgaon truck terminal would be relocated to a nearby place belonging to the Bangladesh Railway, which might save large parts of Tejgaon and Kawranbazar from severe traffic congestion and hence noise pollution.
- The decision to relocate the Gabtoli, Saidabad, Armanitola and Mohammadpur truck terminals has also been taken which would reduce the noise level in those areas.
- The decision has been made to relocate most of the bus stops, demolish passenger sheds and build new ones at suitable places

3.4.2 Industrial Operation

A large number of industries are located in three specific areas, though some are sited in a scattered manner in different parts of the city. Tejgaon and Hazaribagh are the major industrial areas of the city, which are identified as red zone for noise pollution. In fact, all these industrial sites are located very close to the major roads of the city. So throughout the day, transport noise and the noise of industries usually occur together. In Tejgaon industrial area, the sound level was found 87 dB in 1999 and 84 dB in 2002, which shows that the sound level exceeded the standards by more than 10 dB in just 3 years. In Hajaribagh, the noise level was measured to be 80.8 dB in 1999 and 80 dB in 2002; both had exceeded the standards. It has been reported that about 16,000 people work in the Hazaribagh tannery industries with continuous exposure to chemicals and noise (Khan, 2003). Besides the workers, many nearby residents, professionals, school children, and medical patients are also highly exposed to this combined noise effect of industry and transport vehicles. However, the industries of the city may be compelled to comply with the above policies and guidelines with a view to reducing the noise level. Enforcement and monitoring on industrial operation is also needed on an emergency basis.

Photo - 3.13. Construction activities

Photo - 3.14. Metal workshop on the street side

Photo - 3.15. Loudspeakers used for selling audiocassettes on the footpath

3.4.3. Construction and Repair Activities

The rapid urbanization, economic development and utility management of the city include construction and reconstruction of residential buildings, commercial buildings, roads and highways (Photo 3.13). All these development activities require brick grinding machines, forklifts, metal equipments, generators etc. that create huge amounts of noise during their operation. These activities have tremendously increased in last few years in the city. Besides these, there are a large number of metal workshops on the roadsides, which use metal instruments for cutting and shaping, as necessary. The continuous hammering activities have extreme effect on everyday life and can cause mental disorder in the people living in close proximity of the sound. Such noise should be controlled by enforcing the above rules and policies.

3.4.4. Use of Loudspeakers and Microphones

The most uncomfortable situation for city dwellers arise when the use of loudspeakers in the shops and markets and microphones for political processions, meetings, picnic parties, lottery ticket selling etc goes beyond human tolerance.

Such nuisance and unnecessary use of microphones and loudspeakers are observed mainly in the daytime all over the city, which seriously bother the city dwellers. Students can hardly concentrate in their studies due to the regular blare of microphones in some areas of Dhaka city. Most of the commercial and administrative areas including Motijheel, Farmgate, and Rajuk Avenue have exceeded the standard limit (WHO, 1999 & 2002). Motijheel and Farmgate were identified as red zones in terms of noise pollution due to the loudspeakers used for selling lottery tickets, for political, social, religious and organizational meetings and processions. Such tremendous levels of noises disturb the people in those areas and may also cause mental and physical illness. The health section of the Environment Policy of 1992 strictly states the need for developing healthy environment for urban areas to ensure healthy workplace for workers (BELA, 1996). Upcoming noise rules may be used to address this situation.

3.4.5. Vehicular movements on uneven/bumpy road surface

Much of the city road surface including major roads, link roads, and lanes and by-lanes are not smooth or clean enough for efficient transportation. Moreover, most of the city roads are frequently dug up for construction activities by the different utility services, and in many cases, the reconstruction job of the road is not properly completed. As a result, the road surfaces become uneven, patchy and bumpy, which in turn causes continuous friction with running vehicles. Following are the necessary actions required to overcome the situation:

- Effective coordination between relevant organizations
- Completion of assigned construction or reconstruction of roads activities
- Frequent digging up of roads

Road surface should be smooth and even otherwise it causes noise and accidents too. Continuous bumping on uneven road surface also reduces longevity of the vehicles.

3.5 Environmental Health

Rapid urbanization, economic activities and development as well as population growth in the last decades have changed the physical environment condition of Dhaka, degraded the city environment through over exploitation or utilization, and the mismanagement of its environmental components. The city environment now is far from the ideal due to many factors and issues that primarily originate from human activities and lifestyle. These factors may be psychological (e.g. stress, human relationship etc.), biological (e.g. bacteria, viruses, parasites etc), chemical (e.g. chemicals or chemical compounds, dust etc.), and physical (e.g. noise, climate, workload etc.). There are

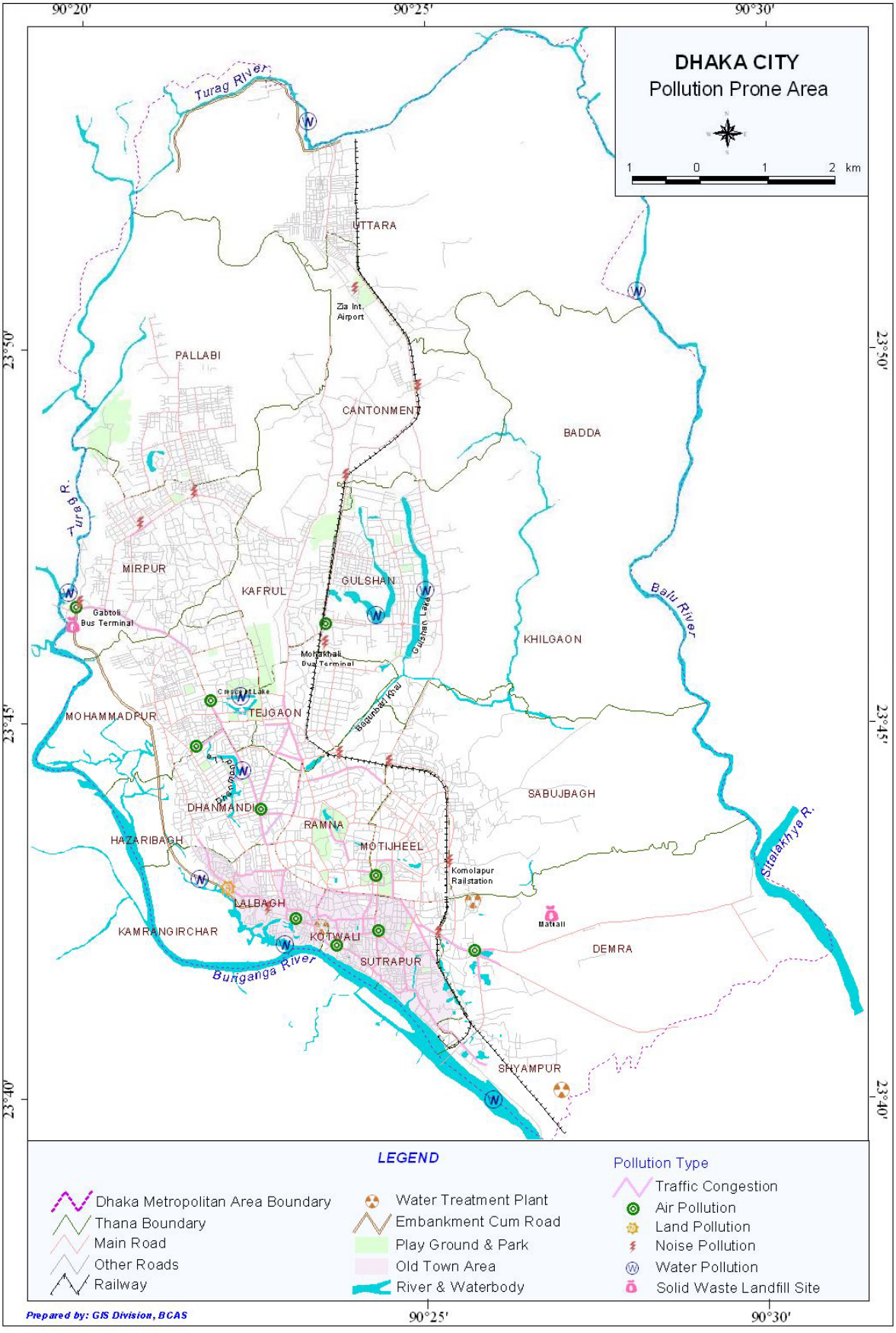


Figure - 3.8. Pollution Zone of Dhaka City by Pollution Type

Table 3.23. Patients in Dhaka Shishu Hospital with Pneumonia

Year	Ad-mitted	Percentage of total patients	Death
July-Dec, 2003	1863	31.14	74
Jan-Mar, 2004	500	32.43	51

Source: DSH, 2004

Table 3.24. Percentage of Patients in Dhaka Shishu Hospital with ARI

Year	Nov-Feb (Winter)	Jul-Oct (Monsoon)
1996	39	25
1998	52	35
2000	56	45

Source: DSH, 2000 in Hussam and others, 2002

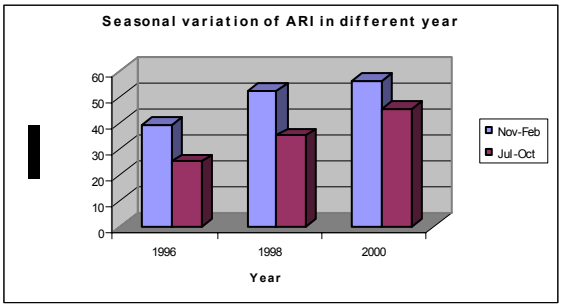


Figure 3.9. Increased Acute Respiratory Infection in different years in DSH (1996-2000)

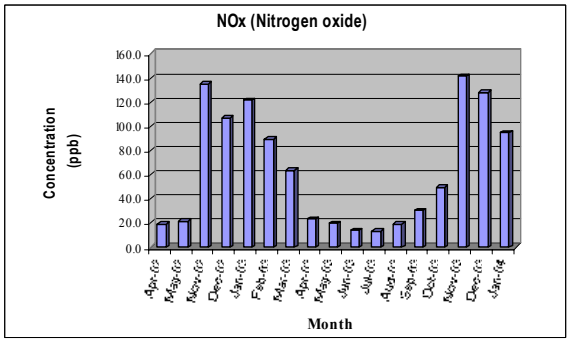


Figure 3.10. Concentrations of NOx

Many types of air pollutants (Carbon monoxide, oxides of nitrogen, sulfur dioxide, ozone, lead, VOCs, Methane and SPM) present in both ambient and indoor air of the city. Though the ambient air condition has improved a bit since the late 1990s with policy decision and drastic actions of the

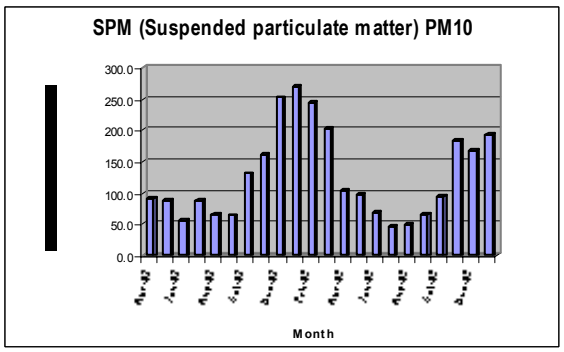


Figure 3.11. Concentrations SPM_{10}

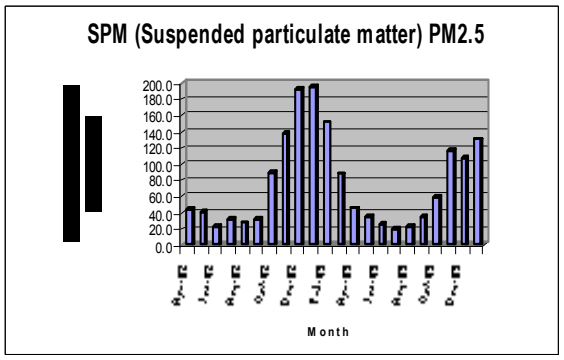


Figure 3.12. Concentrations of $SPM_{2.5}$

government, but still the indoor air situation is highly hazardous, especially in the slums and squatter settlements. As mentioned earlier, the concentration of SPM in the indoor air of slums is 4,040 to 18,586 micrograms per cubic meter, which is much higher than the standards (WHO, 2002). Besides air pollution, noise and contamination of both surface and groundwater threaten human health. Some of the areas of Dhaka city are recognized as pollution zones. Figure 3.8 presents pollution zone of Dhaka City. The following are the major environmental health concerns for Dhaka city that adversely affect human health.

3.5.1. Air Pollution and Human Health

The recent government initiatives have reduced concentration of air pollutants but some pollutants like SPM, Ozone, Oxides of Nitrogen, VOCs are still on the higher level particularly in the dry season.

Moreover, the size of the population exposed to concentrations of SPM, O_3 and NOx has

Table 3.25. Patients in Dhaka Shishu Hospital (DSH) with Diarrhea

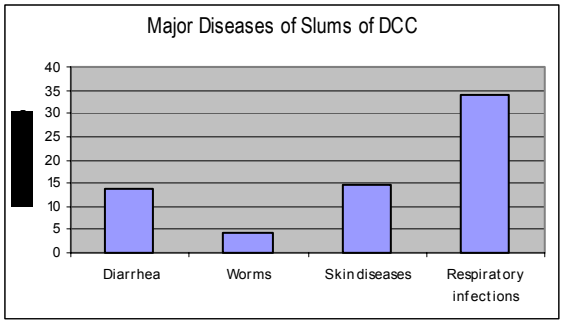
Year	Admitted	Percentage of total patients	Death
July-Dec, 2003	1286	21.5	17

Source: DSH, 2004

Table 3.26. Major diseases of slums and squatters

Diseases	Percentage
Diarrhea	13.6
Worms	4.3
Skin Diseases	14.8
Respiratory infection	34.0

Source: Dana, 2002



Source: MCH-FP in WHO, 2002

Figure 3.13. Different diseases of slums and squatters of Dhaka city

tremendously increased in the last few years due to excessive growth of population.

The above might be the reason of increased surrering and deaths by respiratory infections, asthma, pneumonia etc. The shocking truth is that the poor, elderly people and children suffer more from these diseases. All these complications become more acute during the dry season. According to the Dhaka Shishu Hospital (DSH), at least 15-20 patients/day come with pneumonia from November to January (dry season) while the number is less than half during other seasons. Nearly 48.62% of the total patients were found to have respiratory problems or symptoms in the period from July 2003 to December 2003, whereas the record of the same hospital shows that the percentage of patients with acute respiratory infections was 56 in 2000. Bangladesh accounts for about 120,000 deaths, including children, every year of which Dhaka city alone may account for the larger part (Dana, 2002). Table 3.23 and 3.24 and Figure 3.9 shows the percentage of patients with pneumonia and acute respiratory infection (ARI) in different years in Dhaka city.

Report of the WHO also shows that nearly 1,20,000 children die every year due to respiratory problems in the country (Dana, 2002). Most of these patients may be severely exposed to SPM.

Continuous Air Monitoring Station (CAMS), Air Quality Management Project (AQMP) recorded the exceeding limits of the following pollutants in Dhaka city from April 2002 to January 2004:

3.5.2. Safe drinking water, sanitation and health

As mentioned earlier that 9 millions of people of Dhaka city living in slums and squatters suffer from inadequate safe drinking water and sanitation services. This situation worsens during monsoon season all over the city causing the spread of a number of water borne diseases like.

- Diarrhea
- Dysentery
- Skin disease
- Fever

In fact, poor people living in the slums and squatters are most affected due to lack of utility services. Patients of diarrhea at the DSH (Table 3.25) and the major diseases of the slums are shown in the following Table 3.26 and Figure 3.13. Due to lack of safe water and sanitation facility, sufferings will increase unless the surface water is managed properly.

3.5.3. Water Pollution

Water is called 'life' due to its most vital role in human existence and sustainability. Water covers 75% of the planet, though 97% of it belongs to the seas and oceans. The rest 3% is fresh water of which only 0.1% is available to

us in the lakes, streams, soil moisture and as exploitable ground water (WHO, 2002). This valuable resource should be maintained with care and efficient management systems but unfortunately, the surface water of Dhaka City is seriously polluted due to –

- Untreated industrial waste: Nearly 50,000 m^3 of industrial waste is disposed off in the surrounding river system (Shamsuzzoha, 2002)
- Huge amount of sewage
- Solid waste disposal
- Large amount of pesticides and agricultural residue washed out to the rivers.

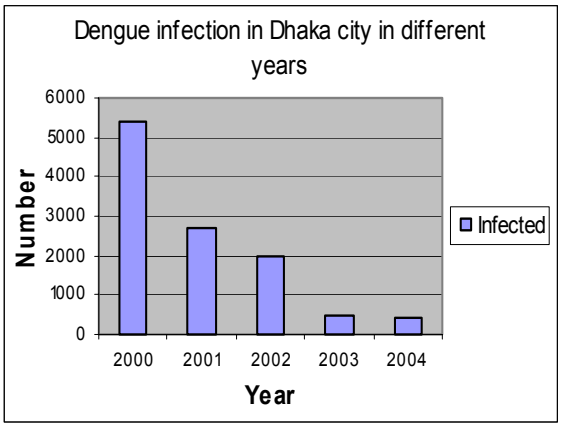
None of the lakes and water bodies is excluded from being polluted. Groundwater may also widely be polluted soon through recharge from of this poor quality of surface water. These scenarios ultimately threaten the aquatic biodiversity, human health and everything that has direct involvement with these water bodies. A large number of people suffer from skin and intestinal diseases particularly in dry season due to use of polluted water for irrigation and domestic purposes. Moreover, treated supply water is also of low quality and is becoming unsafe due to the presence of microbes.

3.5.4. Increasing occupational health risks

Most of the industrial and solid waste workers do not have the opportunity to take precautionary measures when on duty. Rickshaw pullers, traffic police and open vehicle drivers are also exposed to air pollutants and noise hazards. Many children work in battery and tannery industries of the city with exposure to Pb, which might cause neurological disorders leading to disabilities. According to a study by SEHD, morbidity rate of tannery workers is 893.85/1000 whereas the average morbidity rate for Bangladesh is 150.92/1000 (Khan, 2003). Existing policies and interventions are very poor in addressing occupational health hazards and safety. The government needs to prepare an Occupational Health and Safety Rule/Policy or guideline to reduce disability, morbidity and maybe mortality as well. Monitoring programme on industrial operation within Dhaka city would reduce occupational health risk, as well as violation of environmental laws.

3.5.5. Unhygienic food

Open air food selling is common in the roadsides of thickly populated areas. Most of these food items are either adulterated or of sub-standard. Kitchens of roadside restaurants are not maintained sanitarily and so diarrhea, dysentery, acidity etc. are common diseases suffered by the low-income group city dwellers. The poor are not the only victims of adulterated food items, but others are also suffering through the consumption of fruits ripened using chemical compounds like calcium carbide, ethanol and preserving agents like dicthen, formalin etc.



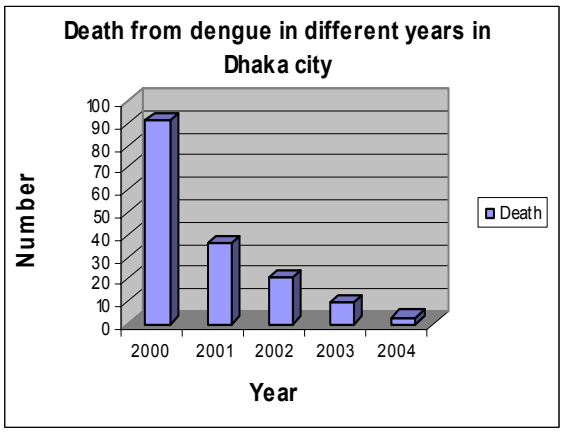


Figure - 3.14. Dengue infection in Dhaka city from 2000 to 2004

3.5.6. Others

The city dwellers also suffer from other diseases, which may be directly or indirectly linked to environmental sources. Open manholes, leaky sewerage lines and unhygienic lifestyle may cause many microbial and vector borne diseases. The city is facing dengue outbreaks every year since 2000. The following table shows the details of dengue outbreaks in Dhaka city:

Table 3.27. Patients in Different Hospital in Dhaka city with Dengue

Year	Infected	Death
2000	5,400	91
2001	2,700	36
2002	2,000	21
2003	486	10
2004 (May-July)	427	03

Source: Health Control Room, Directorate of Health, 2004.

DCC is inadequately prepared to actively combat the mosquitoes problem that cause diseases like dengue and malaria. Even though the incidence of dengue fever has decreased, the mosquito problem prevails. The government must take the initiative to clean up the city otherwise more problems may occur in future.

3.6 Solid Waste Management

Dhaka City Corporation (DCC) holds the official responsibility for collection, transportation and final disposal of everyday solid waste generated within its service area. DCC divided its area into 10 zones for management of solid waste generated in the domestic, commercial, industrial and medical sectors. The total solid waste management involves 3 departments namely Conservancy, Transport and Mechanical Engineering for smooth and easy operation with specific functions - firstly, removal of refuse from the public streets/drains; secondly, collection, transportation and disposal of refuse; thirdly, providing dustbins and other receptacles for accumulation of solid waste. The conservancy department currently holds 370 trucks and container carriers, 4,920 bin/container and 300 handcarts. It is supported by 7,156 cleaners/ sweepers and 190 supervising officers and only 1 officer to supervise transports, for all desired activities (DCC, 2004).

A number of studies were undertaken from time to time by the World Bank, Bangladesh Centre for Advanced Studies (BCAS), Japan International Cooperation Agency and DCC itself for assessment of waste generation. JICA has prepared "Clean Dhaka Master Plan" that will address solid waste management of Dhaka city.

According to a World Bank report, the solid waste generation of Dhaka Metropolitan area (360 sq km) in 1998 was 3,944 tons/day (WB 1998a in BCAS, 2003). Report of "Solid Waste Management Project" of DCC prepared by JICA and DCC experts in 2000 shows that the metropolitan area of the city generates 4,750 tons of solid waste everyday. Another report stated that the waste generation of DCC area was no less than 3,700 tons per day (Imtiaz and Alam, 2002). DCC and some other reports state that the waste generation of DCC is about 4,000 to 5,000 tons/day (personal communication and The Daily Star, 21 June 2004). On the other hand, JICA team of "Clean Dhaka Master Plan" found the existing solid waste generation (dry season) within Dhaka City Corporation area to be 3,340 tons/day, will increase to 4,600-5,100 tons/day in 2015 (JICA, 2004). The team also mentioned that the waste generation would be a little higher during the summer when fruits are available abundantly, which may result in 3,500 tons of average waste generation per day (JICA, 2004).

Of the total waste produced, nearly 20% is used for recovery and recycling and about 37% remains scattered laying around on roadsides, open spaces or in drains. It should be noted that JICA's study was limited to 131 km^2 area of the city whereas DCC's solid waste management service area is 276 km^2 (JICA, 2004). Depending on the above reports and

JICA's findings, it may assume a mid-figure of about 4,000 tons of solid waste generation within the DCC area everyday. These wastes are deposited together in the same primary depots from where about 45% is finally disposed of either by the DCC or Community Based Organizations (CBOs) in the open landfill sites at Matuail near Jatrabari, Beribadh in Mirpur and in Uttara.

3.6.1. Residential and Commercial Waste

Residential and commercial sources produce most of the total municipal waste. The JICA study shows 63% (2120 tons/d) of the total waste (3,340) is from residential sources while another project of the Dhaka City Corporation (DCC) estimated that it is 49.08%. Other sources, for example commercial and industrial waste volume is not specified clearly in JICA's "Clean Dhaka Master Plan" study but according to DCC and some other recent studies, commercial waste generation is no less than 20% of the total (Bhuiyan and others, 2002).

Inadequacy of Collection

A major part of the solid waste of the DCC remains uncollected. This uncollected waste mostly remains in bins, temporary roadside depots, and open spaces or street sides (see photo 3.16), causing a number of problems:

- Uncollected waste occupy huge spaces of the city streets causing traffic congestion.
- Uncollected waste in temporary depots often get burned that reduces air quality.
- Aerosols and dusts can spread microbes from uncollected and decomposing wastes.

Box 3.7. Deficiency of Conservancy Department, DCC

Item	Year		
	1992-93	1996-97	2002-03
Expenditure (Million Tk.)	158.86	256.31	476.00
Tax Revenue (Million Tk.)	47.65*	76.89*	146.00
Deficiency (Million Tk.)	111.21	179.42	330.00

* Estimated

Source: DCC, 1999; Rahman & Islam, 2002; JICA, 2004

Photo - 3.16. Uncollected solid waste on a main street

- Waste that is disposed of here and there and not collected properly can cause severe aesthetic nuisance in terms of smell and appearance.
- Uncollected waste may produce dirty water that mixes up with nearby water bodies and degrade water quality.
- Uncollected waste creates discomfort to pedestrians, particularly the children and aged people.

Hazardous items like broken glass, razor blades and explosive containers may pose health risks especially on that population who partially live off the waste disposal sites. In fact, a number of people collect food items or things for reuse from the uncollected wastes or even from final waste disposal sites.

Large quantities of solid waste remain on the street everyday in the residential, commercial and industrial areas. This causes bad odor, which is very uncomfortable for pedestrians and local people. The school-going children face problems due to the temporary roadside waste depots, especially in the old town, that may have already lost its load capacity.

The DCC is still quite unable to keep up its utility services due to its budget constraints and lack of other resources. The conservancy tax revenue of the DCC is lower than its expenditure, which is the main reason behind inadequate solid waste collection and management. It was found that the DCC spent 476 million taka in 2002-03 for solid waste management, while the conservancy tax

DCC has engaged a large number of NGOs, CBOs and private companies for collection, disposal and recycling of municipal solid waste

revenue was only 146 million taka. Expenditure on SWM has increased in last few years but the gap between expenditure and tax revenue remained high.

The DCC is also unable to collect and dispose of all solid wastes due to rapid increase of population and waste everyday. On the other hand, many transport vehicles and equipment are not used daily, which also results in the low level of waste collection. The DCC, however, engaged a large number of NGOs, CBOs and private companies for municipal solid waste collection, disposal and recycling activities. Of them, 47 have started working recently in 57 out of 130 wards (JICA, 2004). Such organizations charge people in the range of Tk. 10 to 1000/household, based on locality and level of income. There are a number of laws and policies, for example, the Dhaka City Municipal Ordinance, 1983; National Environmental Management Action Plan (NEMAP, 1995-2005); Urban Management Policy Statement, 1998; National Policy for Water Supply and Sanitation, 1998; enforcement of which will enhance solid waste management in the city. However, a separate policy or regulation for solid waste management may be considered.

Waste Concern is a national NGO working on solid waste management issues in about 20 cities and towns of Bangladesh, especially Dhaka and Khulna. They have initiated recycling and reusing of solid waste in Dhaka city. Waste Concern owns four compost plants with a total capacity of about 15 tons/day.

Photo - 3.17. Matuail landfill site (open and without leachate treatment technology)

Photo - 3.18. Municipal waste worker without safety measures

These plants are located in Mirpur, Baily Road, Green Road and Dhalpur area of the city. Another NGO in Kalabagan started helping in SWM of Dhaka city. They collect waste from the households and dispose of them into the municipal depots. However, door-to-door collection rate of solid waste needs to be increased, otherwise the city environment and quality of life will be degrading further.

Management of solid waste landfill sites

According to the CDMP of JICA, the DCC currently disposes of about 44% of the total generated waste (3,340 tons/day) at 3 landfill sites located at Matuail (20 ha), Beri Bund (2 ha) and Uttara (1 ha). Matuail receives 65% of the total disposal volume, Beri Bund and Uttara receive 30% and 5%, respectively. All these landfill sites are open, with no gas collection system or leachate treatment technology. The Beri Bund landfill is very close to the Buriganga River. Matuail, the major landfill (Photo 3.17) site is located within 1 km of residential areas (for example Jatrabari, Jurain). Actually, most of the abandoned landfill sites are also close to residential areas.

Many of the households and even individuals do not dispose of their waste properly in the bin or roadside container. On the other hand, none of the municipal waste workers or even community workers take safety measures during performing their duty (Photo 3.18). The Municipal authority is also very negligent in this regard, due to its management constraints,

particularly financial and technical. Slum housings are very compacted and usually remain beyond the collection system. Improper solid waste management causes the following problems.

- Degradation of air quality with emission from open landfill sites.
- Creation of extreme discomfort to nearby residents (e.g. bad odor, flies).
- Aggravates surface water pollution.
- Ground water pollution.
- Surface soil contamination.
- Microbial breeding ground.
- Induces and aggravates health disorders (long-term exposure to chemical agents, for example, benzene may cause cancer.

The authority suffers from a number of limitations as regards proper management of solid waste of Dhaka city. These are

- Budget constraints (inadequate fund)
- Inadequate supervision of municipal waste collection and disposal
- Inefficient work force for waste collection, transportation and disposal
- Lack of logistic support, for example, manpower, transport vehicles, equipment

Box 3.7. Banning Polythene Bags

- *The government has banned production, distribution, marketing and using polythene bags for any purpose from 1st January 2002 in Dhaka City*
- *A study found that 90 % of the total 5.5. millions polythene bags flow into the sewerage system everyday in Dhaka city. Banning of polythene bags might reduce drainage blocks (Ahmed and others, 2002)*
- *Polythene bags are no more component of municipal solid waste*
- *Public health is protected from polythene related hazard*
- *Rain water infiltration would be increased*
- *Increased use of jute/leather made bags and materials*

Photo - 3.19. Municipal waste remain uncollected

- Absence of primary segregation of solid waste
- No official record of waste measuring, collecting and disposing data/ information
- Lack of efficiency in maintaining time-schedule for waste collection, transportation and disposal
- Professional negligence
- Lack of transparency and accountability
- Dysfunction of transport and mechanical support

The DCC has recently established a Solid Waste Coordination Cell to improve the present management and system of collection. A pilot project was initiated in Rampura (Ward-22) to create awareness among the people about proper management of solid waste of Dhaka city through stakeholder participation. Waste Concern also initiated a waste treatment plant with financial support from the DCC and the UNDP. National Clean Development Mechanism (CDM) Strategy 2004 has been prepared by the Ministry of Environment and Forest (MoEF) that addresses the waste related issues. Under the strategy, the emissions from landfill sites would be used to generate electricity. However, solid waste should be managed in a sanitary manner, otherwise the above-mentioned problems will aggravate further.

Inadequate solid waste management

Many slums and squatters do not have access to solid waste management service from DCC or CBOs and NGOs. Due to lack of this utility

service, large volumes of domestic waste of the slums and squatters remain uncollected. A recent report indicated that 91% of the total slum dwellers dispose of their waste into low-lying lands, near railway tracks, drains, canals, on the streets or open spaces (Mohit, 2000). Dumping of solid waste into such places is increasing with unabated rural to urban migration of low income group of people which poses a real threat to the city environment and causing the following problems.

- Inadequate service results in waste dumping in drains, which result in the overflow and blockage of the drainage system
- Continuous illegal dumping is reducing open spaces of the city
- Surface water pollution is aggravated due to direct dumping from nearby slums and squatters
- Disappearance of a number of small water bodies of the city may be due to continuous waste dumping
- Health hazards for waste disposal workers and residents living near the dumps.

The government had banned polythene bags (Box 3.7) in January 2002, which has reduced associated problems and risks, particularly solid waste generation and clogging in drainage system. The city authority realized the gravity of the situation and therefore approved of a number of CBOs, NGOs and private organization participating in waste collection and disposal. As mentioned earlier, these organizations are working in many areas of the city including Gulshan, Banani, and Uttara. Besides the initiative of the DCC, there are a few other programmes undertaken for better management of solid waste (Islam and Shafi, 2004). The noteworthy initiatives are as follows.

- UNICEF's Support for Urban Basic Services Delivery
- ADB's Primary Health Care Project
- UNDP's Local Initiative for Environment, LIFE (Local Initiatives Facility for Environment)
- Kitakyushu Initiative
- "Urban Solid waste Management Handling Rules of Bangladesh' is being prepared by the Ministry of Environment and Forest (MoEF) with support from UNDP.

The solid waste management services should be available to a satisfactory level for all households in the city for the protection of the city's natural resources and on environment. In fact, it is the millions of low-income group people living in slums and squatters that support this city in the transport, industrial sectors, particularly garments, and municipal conservancy service. Many of them are unable to work regularly due to illness caused by microbial diseases. This is likely to increase in future and might have adverse impact on socioeconomic development unless immediate interventions take place for proper and adequate SWM service.

Solid Waste Management Master Plan

JICA had prepared a Solid Waste Management Master Plan for Dhaka City Corporation in 2005. The Master Plan highlights the current status of solid waste management, solid waste associated problems, analysis of cost and benefits, institutional arrangement, and financial aspects etc. The Master Plan identified a number of programmes to improve the situation. Of them, four have been extracted to implement between April 2005 to March 2006. These are Participatory SWM Programme, Capacity Building of Collection/Transportation Programme, Final

Photo - 3.20. Solid and liquid wastes of Tejgaon industrial area are on the way to water bodies

Disposal Site Improvement Programme, Solid Waste Administration and Management Improvement Program. It is expected that if the recommended programmes are implemented properly, the situation will be much improved.

3.6.2. Industrial Waste

There are 3 designated industrial zones within the city corporation area, viz. Hazaribagh, Tejgaon and Shyampur. Different types of industries including tannery, dyeing and textile, printing, metals, rubber, chemicals and pesticides, battery, distillery, plastics, brick manufacturing, jute etc are a few mentionable ones. A number of industries or factories are also there scattered around the city. In addition, nearly 2000 garments industries have been established within the city area in the last 20 years.

A few studies were conducted at different times on solid waste generation from different sources, including industry and factory. A study conducted by the DCC in 1999 shows industrial contribution of solid waste in the city is 835 tons/day, which is 23.65% of the total waste (DCC, 1999). Another report prepared by JICA in 2000 shows industrial solid waste generation in Dhaka city to be no less than 1150 tons/day, 24.21% of the total 4,750 tons/day. On the other hand, JICA's recent study, which was limited to an area of 131 km^2, records only 200 tons of solid waste generation in the industries and factories. Most part of the industrial wastes are disposed of into municipal bins or containers. The rest of the industrial solid waste, not collected from the factories or the bins, directly or indirectly goes into the nearby water bodies. The waste that flows into the water bodies also includes nearly 50,000 m^3 of untreated liquid waste (Shamsuzzoha, 2002). In fact, none of the industries has any primary segregation activity for solid waste in place. The huge amount of potentially harmful industrial waste from tannery, textile and dyeing, chemical, soap and battery factories containing hazardous elements is disposed of together with domestic and commercial wastes. This causes significant health threats to waste pickers, municipal workers, recycle and reuse workers, nearby residents and even pedestrians. Municipal waste management workers might even get cancer in future due to long-term exposure to these chemical and hazardous wastes. Workers in the tannery and dyeing industries get sick frequently. Long time accumulation of tannery waste on the ground may also reduce surface soil quality. Some of these chemicals may accumulate in fish, food or crop when water from these sources is used. These are attributed to lack of

- Enforcement of relevant policies, rules and regulations
- Awareness of factory owners and workers
- Transparency and accountability of relevant workers and officials
- Occupational health and safety rules
- Industrial waste management guideline/ policy

There are sufficient laws and rules of compliance which can address industrial waste management (JICA 2004). Key of them are as follows.

- Environment Conservation Rules of 1997
- Environmental Management Plan
- Pollution Effect Abatement Plan
- Emergency Plan for Adverse Environmental Impact and
- Environmental Impact Assessment Plans

The government has recently taken an initiative to relocate tannery industries from Hazaribagh to Savar, in the extreme west of Dhaka Statistical Metropolitan Area (DSMA). This may reduce both industrial waste generation and occupational health risks. Awareness of industry owners and workers, and enforcement of existing policies are an immediate requirement. Industrial waste management guideline should be formulated urgently to manage and reduce waste, otherwise occupational health risk will increase and industrial performance and product quality will also be hampered.

3.6.3. Medical Waste

According to a number of recent reports on solid waste management and health care waste management, all the hospitals, clinics and

diagnostic centers together generate about 200 tons/day of waste, of which 40 tons are infectious (Islam and Shafi, 2004; Dana, 2002; Imtiaz and Alam, 2002). The recent study of JICA found 722 government and private hospitals, clinics and diagnostic centers within the 131 km^2 of the DCC. In fact, the number would be no less than 1000 if doctors' chambers were included since they also generate waste, but none of the above reports included them. Except ICDDRB, hardly any other medical centre has proper waste management system in place. This generates a number of problems that are given below:

- A major portion of the infectious waste may remain uncollected posing severe health risks for doctors, nurses and responsible medical waste workers, municipal waste workers, and NGO/CBO workers.
- Hazardous waste may get absorbed into groundwater aquifers from both temporary and permanent landfill sites, polluting ground water.
- Contamination of air may take place through chemical and radioactive wastes. Nearby residents, scavengers and general people are also exposed to chemical waste containing carcinogenic agents.
- Dumping of hazardous wastes into water bodies degrades its quality and threatens aquatic ecosystem.
- Medical waste may reduce soil quality due to improper dumping.
- "A recent study determined that the health care waste handlers are comparatively at higher risks than municipal waste workers and sweepers in Dhaka city (Imtiaz and Alam, 2002).

The government and a few non-government organizations, particularly Bangladesh Centre for Advanced Studies (BCAS), Bangladesh Rural Advancement Committee (BRAC), International Centre for Diarrheal Disease and Research of Bangladesh (ICDDRB), Waste Concern etc have taken initiatives at different times for creating awareness among the medical professionals about medical waste and its safe handling and disposal, and development of environment friendly medical waste management systems. At present, the following things are lacking to address medical waste in the city.

- Legal requirement
- Awareness about medical waste and its consequences
- Professional ethics
- Technical efficiency
- Transparency and accountability
- Enforcement of existing relevant policies, rules and regulations.

Occupational health risks will increase unless the medical centers that include hospitals, clinics, diagnostic centers and doctors' chambers of Dhaka city manage their hazardous and infectious waste in a safe and sanitary manner. Department of Health Services, Ministry of Health and Family Welfare has recently developed a manual on hospital waste management in 2001.

Besides guidelines, the Department of Environment has recommended guidelines/ rules to include environmental aspects in the "Ministry of Health and Family Planning Clinic Act 1999" (Akter, 2002). A very recent initiative was the "SAARC Workshop on Solid Waste Management" held during 10-12 October 2004 in Dhaka. The Ministry of Environment and Forest, Government of the People's Republic of Bangladesh organized this with financial support from the Ministry of Foreign Affairs and the SAARC Secretariat. This workshop recommended that hospital waste should be treated as special waste and managed separately.

Recently, a roundtable meeting was jointly organized by Monwara Hospital and the Forum of Environmental Journalists of Bangladesh (FEJB) to address improvement of existing situation of hospital waste management (The Bangladesh Observer, 11 December 2004). However, an effective specific policy or guideline should be formulated for better management of medical waste immediately, otherwise the situation will further deteriorate adversely impacting socioeconomic development as well.

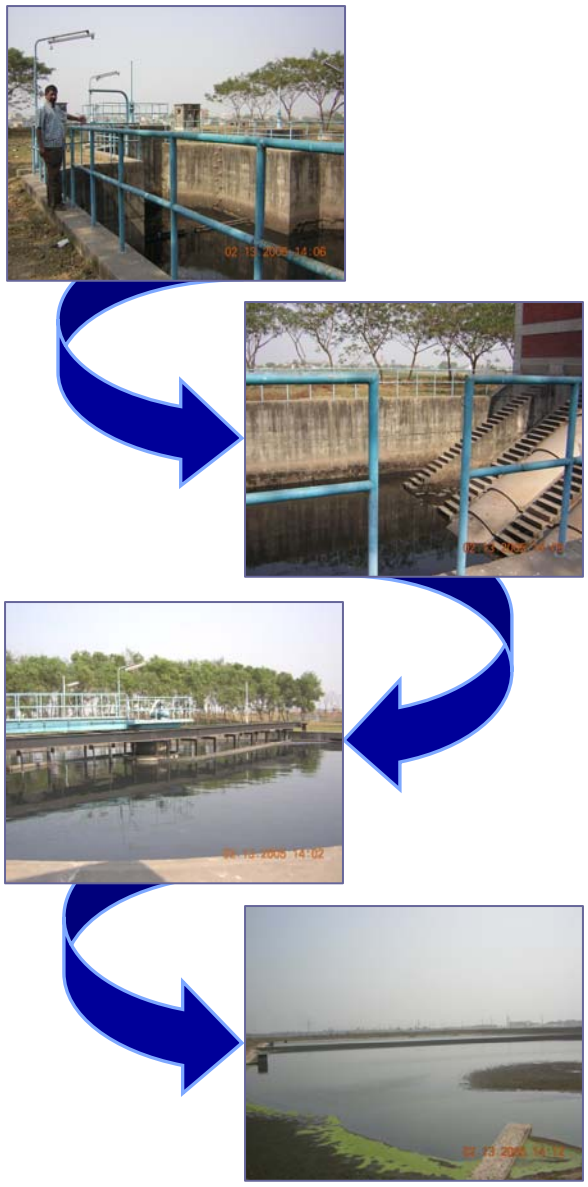


Photo 3.21. Different stages of sewage treatment of the plant

3.7. Sewerage Management

Dhaka Water Supply and Sewerage Authority (DWASA) under the Ministry of Local Government and Rural Development (LGRD) is presently responsible for operation and maintenance of the sewerage system and sewage treatment plants, the total sewerage management, and supply of drinking water within the defined area of Dhaka city.

3.7.1 Sewerage System Of Dhaka City

There exists six WASA zones in Dhaka city for this crucial utility service. Zones 1 and 2 mainly cover the southern part of Dhaka (Hazaribagh, Lalbagh, Sutrapur, Motijheel, Shampur), Zone 3 the western side (Dhanmondi and Mohammadpur), Zone 4 the northern part (Kallyanpur, Agargaon and Mirpur), Zone 5 covers partly central and north-east Dhaka (Tejgaon, Gulshan, Baridhara, Uttara) and lastly Zone 6 covers eastern and central parts of Dhaka (Khilgaon, Shabujbag, Ramna) (Figure 3.15). According to WASA, the existing sewerage system holds 49,803 sewer connections, 26 sewage lift stations and 785.82 km long sewers (WASA, 2004). The length of the sewer lines varies in different zones with the maximum in Zone 1 that holds 168 km and minimum in Zone 5 that covers 88 km. The size of the sewer line also varies from 4 inches to 72 inches in diameter. However, the area and the type of current sanitation coverage of Dhaka city is as follows (personal communication and The Daily Star, 13 July 2003).

- Conventional water borne sewerage system (30 %)
- Separate sewerage system (20 %)
- Septic tank (11 %)
- Pit sanitation (18 %)

3.7.2. Sewage Treatment Plant

DWASA operates a sewage treatment plant a Pagla, namely Pagla Sewage Treatment Plant (PSTP) that treats wastewater of millions of people of Dhaka city. The capacity of this treatment plant is only 0.12 million m^3, while the total sewage generated by the city, as estimated by DWASA, is about 1.3 million m^3. However, the following are the current flagrant concerns that require immediate consideration by the policy makers for environmental sustainability of the city.

3.7.3. Damage of Sewerage System

A recent study by JICA on the sewerage system reveals that Dhaka city sewerage suffer from extreme improper management and operation. Many points of the sewerage network are extensively damaged, for example, the sewerage lines from Tejgaon to Pagla either have leakages or are broken (The Daily Star,

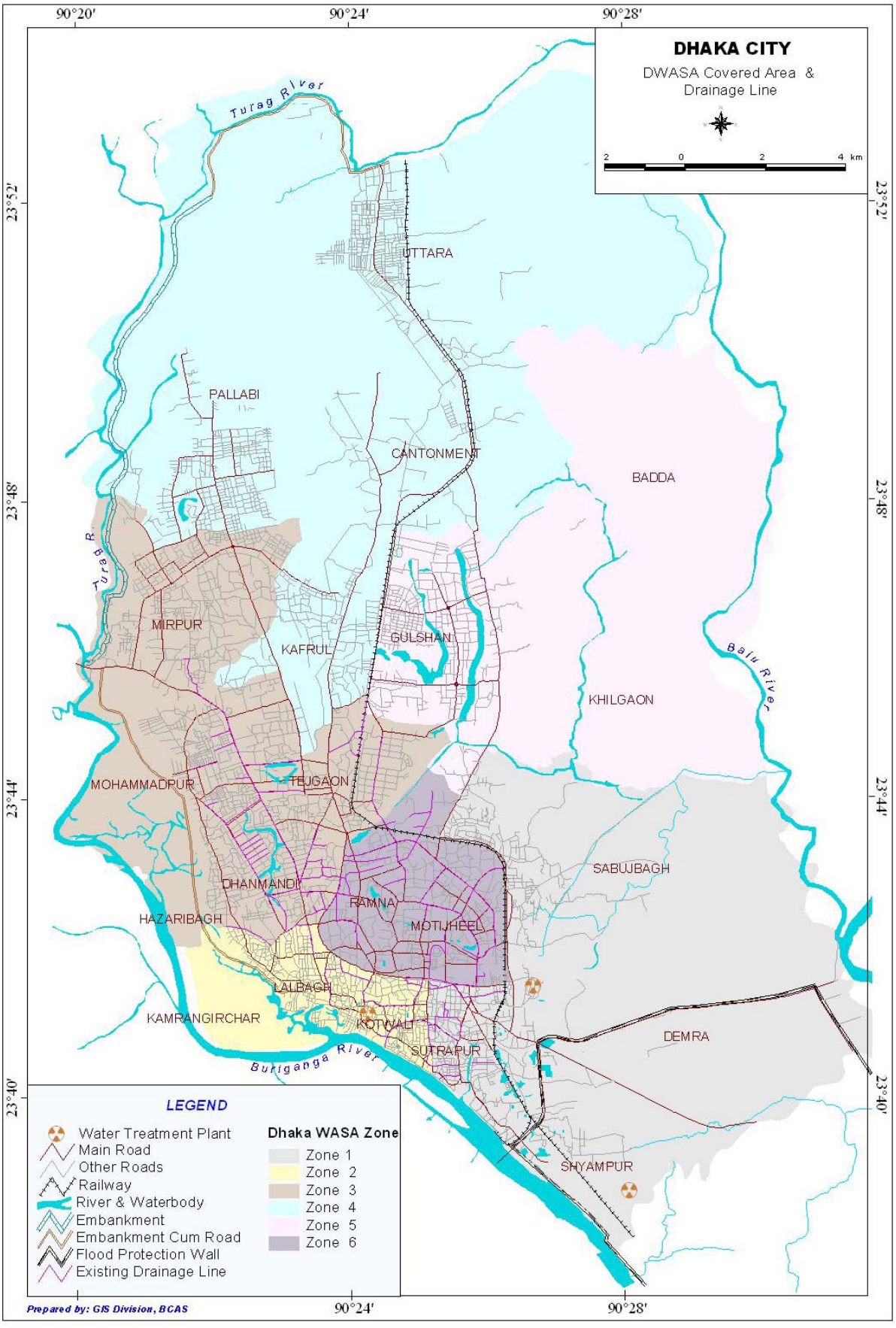


Figure - 3.15. DWASA Coverage Area and Drinage Line

Photo - 3.22. Open manhole in Jatrabari area

Photo - 3.23. Sewage overflow in old Dhaka

13 July 2003). Many areas of Dhaka, particularly the southern part (old city), are home to very unhygienic conditions due to broken and damaged sewerage lines.

Open and lidless manholes (Photo 3.22) are a common phenomenon in most areas of the city. These areas regularly experience overflow of sewerage lines, drains and manholes that makes the surrounding environment unhealthy with bad odor and contamination of air and water (Photo 3.23). WASA has already found microbial contamination of ground water in old Dhaka (WASA, 2003). Also, road transportation and communication become slow and risky due to broken manholes or sewerage lines. Open manholes are also a hazard as there are regular occurrences of people, especially children and older people, falling through the manhole or damaged open sewerage ducts, which sometimes results in death. Moreover, the sewage runoff becomes a nuisance during the flood and in the rainy season, particularly in the eastern and old parts of Dhaka. The overflow of sewage occurs due to the following reasons.

- Damaged sewerage lines/man-holes (leakage, blocked, broken)
- Ineffective design of existing sewerage system (e.g. gradient of lines)
- Lack of sewerage system rehabilitation
- Inadequate monitoring of sewerage lines and man-holes
- Many pipes are smaller than required in diameter
- Excessive flow of sewage from real estate developments/apartment buildings overloads the system which had not been designed to accommodate the current increased sewage flow
- Lack of proper management and operation of both sewerage system and sewage treatment plant

The abovementioned problems are further compounded by the following:

- Natural disaster (e.g. flood)
- Excessive population
- Management constraints (e.g. financial lacking)
- Lack of transparency and accountability

The government and the international organizations (for example World Bank, Asian Development Bank, Japan International Cooperation Agency) have taken several initiatives for improving the sanitation services in Dhaka city. Messrs McDonald & Partners did the first study on sanitation services of Dhaka city in 1990. The 3rd Dhaka Water Supply Project has repaired some damaged lines and also extended the system (WB, 1996). The World Bank completed a feasibility study on improved sanitation services in South Dhaka in 1996 as part of 4th Dhaka Water Supply Project (Shamsuzzoha, 2002). According to a recent report, WASA has cleared 474 major sewer line blockages out of 479. The report also identified maximum blockages occurring in Zones 1 and 2 (old Dhaka). In fact, the occurrence of damage to

Table 3.28. Sewerage system and sewage scenario of Dhaka city in different year

Year	Sewer line (km)	Sewer connection (Nos.)	Approx. Sewage generation (m^3)	Sewerage system coverage area (%)	Capacity of treatment (m^3)	Actual treatment (m^3)	Lack of proper treatment (m^3)
1998	640	44,000	0.90 million	15	0.12	0.10 million·	0.8 million
2003/ June	779	48,777	1.20 million	30	0.12	0.05 million	1.15 million
2004/ June	786	49,707	1.30 million+	30+	0.12	0.05 million	1.25 million

Source: WASA, 2003; WASA, 2004; The New Age, 16 April, 2004 and personal communication).
* *Estimated*

sewerage lines has been gradually increasing in all over the city. So, the sustainability of the city environment in term of sewerage management is under severe threat due to the increasing growth of population (especially low income group), in a limited area and lack of utility service capacity, particularly sanitation.

The government might need a detailed study on the existing sewerage system throughout its servicing area. This study must identify the current sewerage lines gradient and its sustainability, reason of damage, blockage and then look for immediate solutions after rigorous assessment of wastewater-associated problems. There is a significant risk of extensively polluting ground water resources with microbial contaminants from damaged sewerage lines. If it occurs widely then life will be really difficult to continue.

3.7.4. Lack of sewerage service and sewage treatment facility

It is mentioned earlier that over three million people live in about 3007 slums in Dhaka city (Islam, 1996). None of them receive any proper sanitation service from the relevant authority. They construct hanging toilets on low-lying land of on water bodies (for example on lake, river). It has been estimated that less than 5% of the total sewage of Dhaka city is treated in PSTP everyday. A large quantity of the rest remains untreated and gets discharged to the surrounding water bodies, particularly the lakes and river systems in Dhaka. This untreated sewage disposal may be one of the reasons for the deteriorating water quality of the city, the Buriganga and other surroundign rivers. In fact, the sewage generation is increasing with increase of population growth but sewage treatment capacity or actual treatment at PSTP remains the same. Table 3.28 shows development of sewerage system over time.

In addition, both solid and human waste discharge into the surrounding water bodies is causing the following problems.

- Deterioration of surface water quality
- Loss of fishes and aquatic organisms
- Surface water inappropriate for industrial, commercial, agricultural and domestic use
- Microbial contamination
- Threat to human health
- Reduction in quality of industrial and bakery products

WASA also proposed four sewage treatment plants to provide service to the following areas of Dhaka city (personal communication):

- Extreme north: Tongi
- Northeast: Uttara and Baridhara
- Northwest: DOHS and Mirpur
- Southwest: Kamrangirchar

A recent study of JICA on North Dhaka Sewerage System identified the need of at least 3 sewage treatment plants to treat the existing wastewater generated. The PSTP was recently upgraded and the lift stations were also

…….chronic depletion of ground water level of Dhaka city is bound to make us think of protecting the surrounding surface water bodies……

Photo - 3.24. Informal settlements in Dhaka City

rehabilitated with financial support of JICA (WB, 1996). The chronic depletion of ground water level of Dhaka city is bound to make us think of protecting the surrounding areas of surface water bodies, even though the rivers Balu, Buriganga and Turag are already polluted. If the Shitalakhkhya also gets polluted, WASA might have to find other sources of surface water, which should be far away from the city.

3.8. Slums and Squatters

Slums and squatters are the informal settlements of Dhaka city that accommodate the low-income group of people. According to a study conducted by Center for Urban Studies (CUS), the total number of slums and squatters in DCC area in 1988 was 1,125 with a population of about 1 million. Another study done by the same organization in 1996 found that the number of slums and squatters have increased to 3007 with 1.5 million population (Islam and Shafi, 2004). Based on an estimation of experts of the Housing and Settlement Directorate and other recent reports, it may be said that the existing slums and squatters of Dhaka city accommodate no less than 3 million people (Siddiqui and others, 2004; Akash & Singha, 2003). This population helps to keep the city alive, by working and supporting various sectors, particularly transport, industry, factory, domestic, utility service, business establishments, small shops, super markets, petty trading, etc. These are the people who take the low level jobs and live in informal settlements under terrible conditions. The population of this low-income group is still increasing in the city, in spite of the number of limitations in the slums and squatters.

3.8.1. Lack of water supply and sanitation facility

Over 3 million people live in slums and squatters of Dhaka city with very little utility service. Water supply has improved a bit, but sanitation service is still very poor and does not meet the requirements of this huge population. Only 55% of the poor households currently receive tap water (Siddiqui and others, 2004). Another report states that less than 40% of the slum dwellers have access to safe drinking water (Sharmin and Rainer, 1999). On the other hand, none of the slums get proper sewerage services from WASA and only 9% of this population manages to get solid waste management services. As a result, both household waste and human generated wastes go directly or indirectly into the low-lying lands, open spaces or water bodies of the city and causes a number of problems. Moreover, inadequate safe drinking water in slums and squatters causes many problems, which are as follows.

- Unsanitary lifestyle.
- Inadequate access to safe drinking water.
- Increased health risks.

The city authority, NGOs and community participation together cannot meet the required supply of water and sanitation services in the slums due to the following reasons.

- Excessive continuous growth of slum population
- Limitation of resources
- Excessive demand of water within service area.

However, the government, the DCC, and other national and international NGOs are working to provide both water and sanitation facility for this huge number of people living in slums and squatters. The DCC has taken a number of initiatives starting in 1993 to improve the water and sanitary conditions of slums and squatters

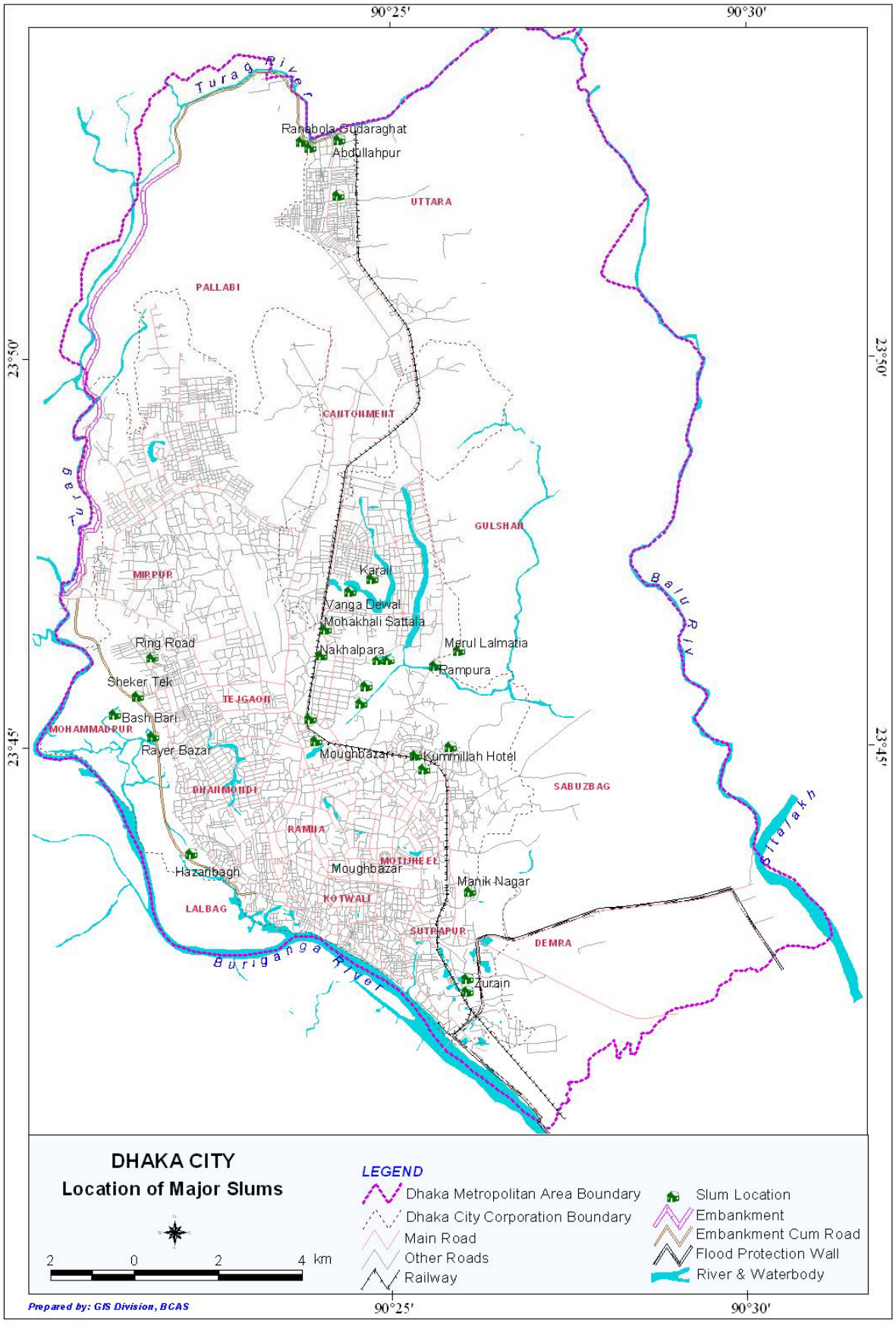


Figure - 3.16. Major Slums in Dhaka City

with regard to the environmental situation of the city. Such activities for slums of Dhaka city can be described as follows.

- DCC has installed 230 sanitary toilets, 42 tube wells, 9 water reserves and 8 biogas plant in different slums areas (DCC, 2004).
- Dustho Shastho Kendro (DSK) has constructed 75 water points to serve the slum dwellers in Dhaka city (Sharmin and Reigner, 1999)
- Water Aid is also providing water for slum dwellers in Dhaka city
- Plan International has installed 17 biogas plants in different slum areas of Dhaka city for better sanitation
- Proshika has provided community latrines in slums of Demra
- Concern has also provided community latrines for slum dwellers.

Inadequate sanitation and scarcity of safe water would adversely impact the environmental resources of the city. Socioeconomic development of the city will also slow down as the city workers should fall sick more and more frequently.

3.8.2. Land use violation

The city suffers extreme inequality in terms of land use practices. It has been reported that only 30% people of this city shares 80% of the total residential area and the rest 70% of the people shares only 20% of residential area (Islam, 1996). However, the first Master Plan of Dhaka suggested that at least 1,184 acres of open space be kept in the city for better conditions of the city environment. This has not been possible since huge areas of open spaces have been occupied by slums and squatters and are used for activities like waste disposal. It may be noted that till 1988, the 1,125 slums and squatters occupied about 1,340 acres of land and this increased to 3007 in 1996.

A study found that nearly 2000 people migrated to Dhaka everyday in the early 90's (GOB, 1993). It is assumed that most of them constructed slums and squatters wherever they found suitable open space (near rail line, bus stops, and parks) to live in. It has been reported that all the thanas of Dhaka Metropolitan Area had slum population, ranging from minimum of 4% of the total in Motijheel and maximum of 46% of the total in Mohammadpur during 1996 (CUS, 1996 in Akash and Singha, 2003). However, both slum settlement and population are increasing and open space is being reduced due to the following factors.

- Rural to urban migration
- Low paid jobs
- Increasing living cost in Dhaka city.

The government has recently prepared its Land Use Policy (Draft). Rajdhani Unnayan Kortripakhkhya (RAJUK) holds two documents for sustainable land use and development of Dhaka city, which are as follows.

- Master Plan for Greater Dhaka, prepared by DIT in 1959
- Dhaka Metropolitan Development Plan, prepared by RAJUK in 1997.

However, addressing this situation, the government, with its own support and sometimes support from development partners like UNDP, has taken several initiatives from 1975 to 1986 to resettle/rehabilitate slum dwellers (Rahman and Tariquzzaman, 2001). Many were resettled from different areas in Mirpur. RAJUK rehabilitated people of some areas in Postagola, Gandaria and Badda, allotting lands at a subsidized rate.

However, the city will continue to fail to provide sustainable environmental support to the millions of slum dwellers unless we make efforts to do so through;

- Enforcement of existing plans and policies
- A study should be conducted immediately to figure out the existing situation of slums and squatters and proper resettlement in view of the general risks they pose on environment, particularly on land resources of the city

- Create awareness about the importance of land resources in sustainable environmental development

3.8.3. Poor housing settlement

All slums and squatters are made of bamboo, straw, low quality wood and tin sheets. Most of them hold a single room for the whole family that makes the slums of Dhaka very congested. According to a recent report, population density in slums and squatters ranges from 700 to 4,210 per acre, and a minimum of four and maximum of ten people share a room, which is highly congested and unhealthy (Akash and Singha, 2003). This poor housing and lifestyle cause a number of problems for the environment of Dhaka city, which are given below.

- Indoor pollution
- Degradation of air quality with frequent slum fires
- Increase incidence of communicable disease that may spread to city dwellers from the workplace.

However, proper housing is a very important factor for social and psychological development of children, but the practical situation of all these informal settlements indicates a dreadful life with poor lighting, ventilation, high crowding and living and cooking either close to or at the same place.

The government has hardly responded to the problem of poor housing in slums and squatters, though some programmes were taken which addressed health care services. Some international organizations (World Vision, OXFAM, Red Crescent and Concern) also took initiatives to provide health care service for slums and squatters of Dhaka city.

Poor housing will worsen above problems and their consequences, unless this situation is improved considerably.

3.8.4. Biomass fuel burning

Due to lack of energy supply, most of the slums and squatters burn biomass fuel for domestic cooking. If it assumes that at least 2 million people residing in the slums and squatters of Dhaka city burn biomass at a rate of 0.25 kg/day/person, this results in 500 tons of fuel burning in a day. The reality may be a little more or less than the assumption, but the amount is still high. Burning of this huge amount of biomass creates several problems for city environment key of which are as follows.

- Deterioration of outdoor air quality
- Reduction of vegetation coverage
- Indoor air pollution
- Deterioration of health
- Slum fire (Box 3.8)

The government may find them alternatives to biomass fuel for slums and squatters considering the above situation. Liquefied Petroleum Gas (LPG) can be used in slums for domestic cooking. The government and NGOs together may take this initiative.

Box 3.8. "Slum fires kill 13 in last 14 months"

According to Ain–O-Shalish Kendra (ASK), at least 13 people were killed in 24 fire incidents between January 2003 and March 2004 in Dhaka City. The following points were identified as the possible causes:

- *Hand-made or kerosene stoves*
- *Mosquito coils or cigarette*
- *Miscreants*

Source: The Daily Star, 5 April 2005

3.8.5. Others (Unsocial or anti-social activity)

Conflict (quarrel, clash, fight) in the slums and squatters is a regular phenomenon. This creates noise and violence that disturbs the city dwellers, particularly the nearby residents, office workers, and school children. Besides, many of the slum residents are involved in prostitution, drug trafficking, hijacking, mugging etc. These activities threaten the social and cultural environments of the city. The government should enforce law and order to improve the overall environment of the city through the reduction of anti-social activities.

3.9. Natural Disaster

Another environmental concern of Dhaka city is recurring natural disasters, which frequently disrupt and damage government, non-government and personal property, road-transport system, drainage system, water supply system and other utility services network. In fact, the whole physical structure of the city gets damaged having dual impact on economy and development--first, pulling the economic growth backward and second, destruction of property and development. Flood is actually the main natural catastrophic event now days for Dhaka city. Dhaka city experienced heavy floods at least 9 times from 1954 to 2004 (Alam and Huq, 2003). Flooding causes huge damages every year, though the flood of 1998 was much more severe than others in terms of extent and duration. However, every time the most impacted group are usually the midlevel and the poor people. They lose jobs, housing, domestic property and suffer from water borne diseases etc. Till 1988, the city was totally unprotected from flood disasters that caused huge damages, sufferings and deaths.

3.9.1 Flood

A recent report shows that 100% of eastern Dhaka was affected by flood in both 1988 and 1998, western Dhaka was 75% affected in 1988 while it was decreased to 23% in 1998 due to the Dhaka Integrated Flood Protection Project (DIFPP), which was implemented by BWDB and funded by ADB and GOB (Nishat et al, 2000). In 2004, Dhaka was inundated again due to flow of about 65 to 200 cm above the danger level of the surrounding rivers. In July 2004, the highest flow of the Buriganga, Balu, Turag and Shitalakhkhya was 65, 195, 135 116 cm above the danger level respectively. This overflow of the rivers brought the most part of eastern city under flood water of about 20 to 300 cm causing serious environmental damage key of them are given below.

Photo - 3.25. Dhaka under floodwater

Photo - 3.26. City roads under floodwater

Sewage Overflow

The DCC's underground and surface drainage systems are meant for storm water drainage and therefore have nothing to do with sewage overflow. Sewage overflow occurs through DWASA's domestic sewerage system due to its inadequacy, lack of maintenance and submergence during floods. In Dhaka city, storm water drainage system and domestic sewerage system are separate systems, although there are numerous illegal connections of domestic sewage into the storm drains. The major part of storm drainage system is, however, constructed and maintained by DWASA.

Inefficient solid waste management

The solid waste management of Dhaka city becomes horrible during floods, mainly due to water logging of roads and temporary bins. During floods, people of east Dhaka directly dump waste into the floodwater, which accounts for more than fifty percent of the total waste generation of the city.

Road Communication Difficulty

In fact, many of the major roads, link roads, and lanes and by-lanes get inundated with floodwater, which hampers transportation within and around the city area. This greatly damages the road surface, for instance, 400 kilometers of roads were severely damaged during the 1998 flood (Chatterjee, 1999). The inter-district road transport system also gets disrupted due to flooding of these roads. Many of the roads of east Dhaka experienced inundation of over 100 cm of water during flood that totally blocked the transport system. Due to transportation blockage, many of the private transport businesses cannot operate their business and vehicles resulting in a large number of job terminations. Floodwater also damages both motorized and non-motorized vehicles.

Crisis of drinking water

One of the most important problems during a flood is the lack of safe drinking water. Most of the reserve tanks of the buildings or houses in affected area are submerged, which results in water crisis. In some cases, where the reserve tanks are protected by building walls around the tanks, the improper maintenance of the water supply pipe causes the water to become contaminated by the floodwater due to leakages in the pipes.

Quality food crisis

The city people also suffer from fresh food crisis during floods. Due to inundation of roads and highways, food and other agricultural products like vegetables cannot reach the city. This results in crisis of nutritious foods.

Increased incidence of water borne diseases

A flood disaster is an extreme threat to human health, especially that of children. Children and elderly people suffer from diarrhea, skin diseases, dysentery and fever. Large numbers of people die from severe attacks of diarrhea, which usually starts from the mid point to the end stages of flood. According to a report, 82,054 people were affected by diarrhea and approximately 300 people died in 1998 flood (Chatterjee, 1999).

The city is not protected against floodwater on the eastern side of Dhaka that caused most of its inundation in 2004 flood. As mentioned earlier, the city has experienced flood disasters a lot of times from 1954 to 2004. But after the serious flood tragedy in 1988, the Asian Development Bank (ADB) has played an active role in assisting the Government of Bangladesh in implementing the Flood Action Plan (FAP) and for the better management of existing flood control and drainage infrastructure. The ADB donated $95.4 million for Flood Damage Rehabilitation Project (ADB, 2003). The flood control and irrigation part of the project was implemented by the BWDB. The government has taken decision to construct an eastern bypass, which may protect the city from further flood affection. However, the embankment - cum-road on the western part of Dhaka has greatly helped to protect nearly 50% of the city from the floods of 1998 and 2004 (Figure 3.17).

According to past experiences, a large number of national and international NGOs contributed relief and rehabilitation programme after the floods receded. WHO, UNDP, UNICEF, CARE, WATER AID, JICA and many other organizations directly contributed to the flood succor in affected areas, taking part in relief, health care services and providing water supply all over the affected areas of the city. The GOB established Flood Forecasting and Warning Centre to reduce the damages and create awareness among the people about the flood situation. The FFWC keeps records and forecasts the water level of major rivers through the Internet and media services. It is, however, essential to implement the DIFPP phase-II to protect the eastern side of the city. In fact, this would greatly help to protect the city as a whole. Proper drainage system in the city might reduce the duration of flood or even water logging within the city. The drainage blockage causes huge problems during floods. The DCC and DWASA should repair and maintain their existing resources properly for better management, otherwise the city might suffer more if extent and duration of floods worsen than in the future.

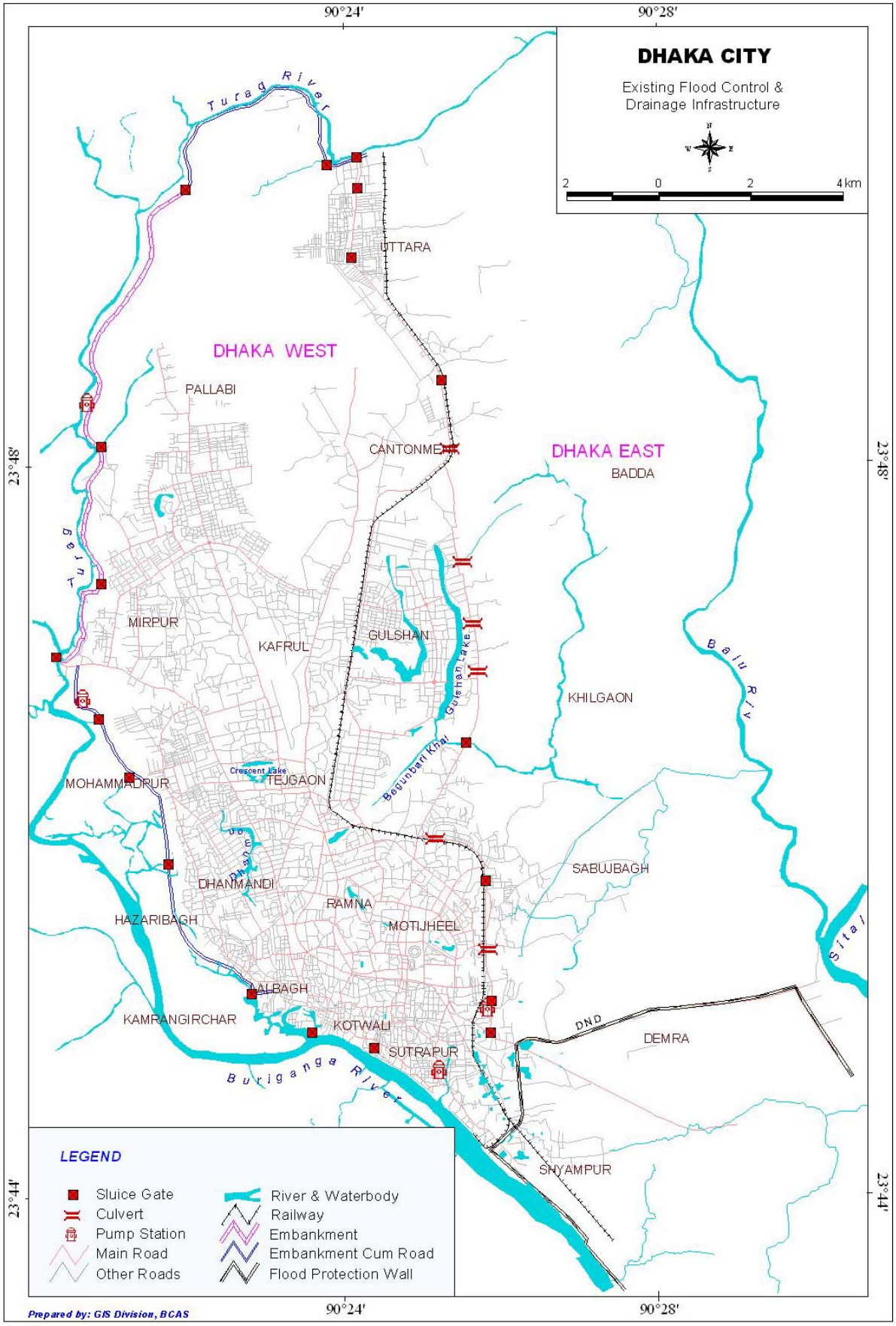


Figure 3.17. Flood Control and Drainage Infrastructure

4. Conclusions and Recommendations

The Dhaka City State of Environment Report 2005 is prepared based secondary data and information available with different government departments, agencies, published reports and books. It is to be noted that data and information also collected from experts working on environment through personal communication. Collected data and information were analyzed using Integrated Environmental Assessment (IEA) Framework. A review team consisting reputed environmental and policy experts provided review comments which have been incorporated in the final report.

The analytical result shows that there is huge competition for resources within and around Dhaka City. All environmental resources are declining at different pace and scale. Degradation of environment is posing, among other, significant health threats for the city dwellers. Air, water, and land are being continuously degraded with high exposure to chemicals and microbes that directly or indirectly cause numerous sufferings and deaths every year. All these have adverse impact on the socioeconomic conditions of the city and therefore, of Bangladesh.

Different ministries, department and agencies of the Government of the People's Republic of Bangladesh have taken a number of initiatives to address environmental problems. Most visible measures to improve air quality of the city are a) banning two-stroke three-wheel passenger vehicle, b) stop using leaded gasoline in the city, c) introduce natural gas driven vehicles. New traffic signaling system, realignment of road and limit plying of un-motorized vehicle in the main road in the day time have also improved traffic congestion.

Community based solid waste management has made a very good example but scale is small compared to the need. Government has recently engaged non-government and private organizations to collect and manage solid waste. There are also initiatives to tap international finance under Clean Development Mechanism (CDM) as a part of better solid waste management.

Generally enforcement of environmental laws, rules, and regulation is very weak due to a number of reasons. Lack of institutional capacity both human and financial are widely talked weakness. Lack of transparency and weak governance are equally responsible for non compliance of laws and regulation.

The following actions are recommended to address key environmental problems.

4.1 Atmosphere

- Strict enforcement of existing environmental and traffic laws, policies and guidelines
- Update transport system and road network of Dhaka city
- Bypass road facility around the City for smooth road transportation
- Partial relocation of industrial, educational, commercial, private and government administrative headquarters to sub/semi urban areas to avoid transport congestion and emissions from vehicles
- Initiation of industrial audit for legal compliance
- Further strengthen the DoE and decentralization of the DoE network
- Improvement of existing monitoring of environmental management
- Industrial registration and establishment of information databank on industries
- Ensure waste treatment plants for both industrial and medical businesses, operation and management
- Introduce environmental awareness programmes for educational institutions, vehicle users, industrial labourers and community people
- Improve utility service within the city area especially water supply and sanitation, and solid waste management.
- Ensure transparency and accountability

- Development of basic air pollution research laboratory
- Initiating/ introducing Green Tax, based on the "polluter pays" principle, where the industry polluting pays a tax depending on the amount of pollution. The tax could be set on emissions, waste disposal, effluent discharge etc from industries and even on individuals polluting the environment through vehicular emissions and littering.

4.2 Water Resources

- Strict enforcement of existing environmental, agricultural and water resource management laws, policy and guidelines
- Industrial registration and establishment of information databank on industries
- Immediate relocation of the tannery industries from Hazaribagh area
- Immediate enhancement of sewerage management capacity
- Mandatory industrial waste treatment plants
- Enhanced solid waste management capacity
- Reduced system loss of water supply
- Rehabilitation of water supply pipes
- Discourage concrete surface development for smooth rain water recharge and avoid drainage congestion
- Ensure transparency and accountability
- Initiating/ introducing Green Tax, based on the "polluter pays" principle, where the industry polluting pays a tax depending on the amount of pollution. The tax could be set on emissions, waste disposal, effluent discharge from industries and even on individuals polluting the environment through vehicular emissions and littering.

4.3 Land

- Effective coordination between DCC, WASA, DESA and other utility service providers to avoid overlapping development activities
- Better enforcement of the environmental, land use and agricultural laws and policy
- Sanitary landfills
- Remediation of tannery waste dumping sites
- Update or formulate a guideline for roads and highways construction
- Introduce environmental management system in industries
- Industrial registration and establishment of information databank on industries
- Continuous monitoring of the petrol pumps operation
- Implementation of DMDP, 1997
- Initiating/ introducing Green Tax, based on the "polluter pays" principle, where the industry polluting pays a tax depending on the amount of pollution. The tax could be set on emissions, waste disposal, effluent discharge from industries and even on individuals polluting the environment through vehicular emissions and littering.

4.4 Noise

- Immediate implementation of Noise Control Regulation, 2004
- Strict enforcement of environmental and traffic laws
- Enforcement of Motor Vehicle Act, 1983 (amended in 1988)
- Stricter inspection of vehicles and establishment of information databank on different vehicle categories
- Ensure transparency and accountability
- Noise awareness programme

4.5 Environmental Health

- Strict enforcement of existing environmental laws, policies and guidelines
- Introduce Occupational Health and Safety Policy or Rules
- Strict monitoring programme to reduce administrative delays and ensure procedural transparency and accountability

- Improved water supply and sanitation services
- Ensure reduction of housing congestion especially in slums and squatters
- Reduced biomass fuel burning
- Protect surface water anyway

4.6 Solid Waste Management

- Sanitary landfill sites
- Improved solid waste management services
- Training for capacity building
- Ensure transparency and accountability
- Increased supervision and monitoring
- Precautionary measures during handling and disposal of wastes
- Ensured appropriate hazardous waste management practices

4.7 Sewerage Management

- Increased sewerage service
- Install sewage treatment plants based on sewage generation
- Ensured timely rehabilitation
- Repair damages
- A detailed study on existing sewerage system and technical gaps should be conducted immediately for further expansion and rehabilitation

4.8 Slums and Squatters

- Resettlement where needed
- Provide adequate utility services including water, sanitation and waste management services
- Introduce LPG for domestic cooking
- Reduce congested housing

4.9 Natural Disaster (Flood)

- Immediate Implementation of DIFPP-phase II
- Update drainage system and network
- Ensure efficient maintenance of supply water pipes and sewerage system
- Strong coordination between core service authorities of the city for efficient development and rehabilitation of damage.

ADB	–	Asian Development Bank
AQMP	–	Air Quality Management Project
ARI	–	Acute Respiratory Infection
BAEC	–	Bangladesh Atomic Energy Commission
BAPA	–	Bangladesh Poribesh Andolon
BBS	–	Bangladesh Bureau of Statistics
BCAS	–	Bangladesh Centre for Advanced Studies
BCES	–	Bangladesh Compendium of Environmental Statistics
BCSIR	–	Bangladesh Council of Scientific and Industrial research
BELA	–	Bangladesh Environmental Lawyers Association
BEMP	–	Bangladesh Environmental Management Programme
BIDS	–	Bangladesh Institute of Development Studies
BIWTA	–	Bangladesh Inland Water Transport Authority
BOD	–	Biological Oxygen Demand
BRTA	–	Bangladesh Road Transport Authority
BRTC	–	Bangladesh Road Transport Corporation
BTTB	–	Bangladesh Telephone and Telegraph Board
BUET	–	Bangladesh University of Engineering and Technology
BWDB	–	Bangladesh Water Development Board
CAAB	–	Civil Aviation Authority of Bangladesh
CAMS	–	Continuous Air Monitoring Station
CARE	–	Cooperation for American Relief Everywhere
CEGIS	–	Centre for Environment and Geographic Information System
COD	–	Chemical Oxygen Demand
CNG	–	Compressed Natural Gas
DCC	–	Dhaka City Corporation
DCH	–	Dhaka Children Hospital
DESA	–	Dhaka Electric Supply Authority
DITS	–	Dhaka Integrated Transport Study
DIFPP	–	Dhaka Integrated Flood Protection Project
DIT	–	Dhaka Improvement Trust
DO	–	Dissolved Oxygen
DOE	–	Department of Environment
DMDP	–	Dhaka Metropolitan Development Plan
DMP	–	Dhaka Metropolitan Police
DPF	–	Disaster Preparedness Forum
DPHE	–	Department of Public Health And Engineering
DSK	–	Dusthya Shasthya Kendra
DTCB	–	Dhaka Transport Coordination Board
DTW	–	Deep Tube Well
DUTP	–	Dhaka Urban Transport Project
DWASA	–	Dhaka Water and Sewerage Authority
EC	–	Electrolytic Conductivity
EIA	–	Environmental Impact Assessment
EPC	–	Engineering and Planning Consultants

FFWC	–	Flood Forecasting and Warning Centre
GEO	–	Global Environment Outlook
GOB	–	Government of Bangladesh
HPSR	–	Health Population Statistical Report
ICDDRB	–	International Centre for Diarrheal Disease and Research, Bangladesh
ICLARM	–	International Center for Living and Aquatic Resources Management
IDA	–	International Development Agency
IGES	–	Institute for Global Environmental Strategies
IWM	–	Institute of Water Modeling
IUCN	–	International Union for Conservation of Nature
JICA	–	Japan International Cooperation Agency
KAR	–	Knowledge and Research
LGED	–	Local Government Engineering Department
MIG	–	Medical Information Group
MMP	–	M MacDold
MOEF	–	Ministry of Environment and Forest
MLD	–	Million liters per day
MSl	–	mean sea level
NIPSOM	–	National Institute of Physical and Social Medicine
NWMP	–	National Water Management Plan
NWRC	–	National Water Resources Council
OECD	–	Organization for Economic Cooperation and Development
RAJUK	–	Rajdhani Unnyan Kotrpakha
RHD	–	Roads and Highways Department
SEHD	–	Society for Environment and Human Development
SEMP	–	Sustainable Environment Management Programme
SPM	–	Suspended particulate matter
STP	–	Strategic Transport Planning
SUEP	–	Society for Urban Environmental Protection
SWMC	–	Surface Water Modeling Center
TDS	–	Total Dissolved Solids
UNDP	–	United Nations Development Programme
UNEP	–	United Nations Environment Programme
UNESCAP	–	United Nations Economic and Social Commission for Asia and the Pacific
UNICEF	–	United Nations International Children Emergency Fund
UNFPA	–	United Nations Population Fund
UPHCP	–	Urban Primary Health Care Project
UTEIS	–	Urban Transport and Environment Improvement Study
VOC	–	Volatile Organic Compound
WARPO	–	Water Resources Planning Organization
WASA	–	Water Supply and Sewerage Authority
WB	–	World Bank
WHO	–	World Health Organization

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Updated data on Table 2.2, 2.8 & 3.2

Table 2.2: Air Quality Data of Central Part of Dhaka City measured at Sangsad Bhaban (Upto 2005)

Month	SO_2 (Sulfer di-oxide): monthly 24-hr average	NO_x (Nitrogen oxide): monthly 24-hr average	CO (Carbon monoxide): monthly 1-hr average	O_3 (Ozone): Monthly 1-hour average	Suspended particular matter (SPM) PM_{10}: monthly 24-hr average	Suspended particular matter (SPM) $PM_{2.5}$: monthly 24-hr average $PM_{2.5}$
Oct, 02	4.3	DNA	1.5	16	131	90
Nov, 02	8.5	134.9	1.6	19	161	138
Dec, 02	19.5	107	DNA	22.9	252	192
Jan, 03	19.3	121.3	2.5	28.9	271	196
Feb, 03	24	89.3	1.6	57.4	244	151
Mar, 03	15.5	63.3	1.1	57.9	202	88
Apr, 03	6.2	23.3	0.4	29.9	104	46
May, 03	1.6	20.0	0.5	20.1	97	36
Jun, 03	0.5	13.9	0.3	DNA	68	27
July, 03	0.5	13.3	0.2	DNA	46	19
Aug, 03	0.7	19.5	0.3	DNA	50	23
Sep, 03	0.3	30.2	0.6	DNA	65	35
Oct, 03	0.5	49.3	1	DNA	93	59
Nov, 03	3.4	141.3	2	38.1	183	117
Dec, 03	7.5	127.6	1.8	27.6	168	108
Jan, 04	5.6	94.8	1.4	29.7	192	130
Feb, 04	9.9	74.2	1.6	43.5	236	119
Mar, 04	3.1	32.2	0.7	29.7	165	103
Apr, 04	5.8	26.7	0.3	16.3	104	104
May, 04	1.8	15.6	0.2	10.6	103	50
June, 04	DNA	18.6	0.3	5	69	29
July, 04	DNA	19.1	0.2	DNA	55	DNA
Aug, 04	DNA	37	DNA	DNA	54	DNA
Sep, 04	DNA	39.4	DNA	DNA	65	DNA
Oct, 04	DNA	0.7	3	18.2	106	70
Nov, 04	DNA	0.3	DNA	45.8	177	121
Dec, 04	DNA	102.6	DNA	41.9	248	136
Jan, 05	DNA	40.9	DNA	53.8	252	166
Feb, 05	DNA	207.8	DNA	59.3	205	116
Mar, 05	DNA	DNA	DNA	DNA	136	101
Apr, 05	DNA	DNA	DNA	DNA	124	80
May, 05	DNA	DNA	DNA	DNA	83	36

Source: *Air Quality Management Project (AQMP), Department of Environment, 2005*

Note: *PM_{10}, $PM_{2.5}$: Concentration in micrograms per cubic meter*
NO_x, O_3, SO_2: concentration in ppb
CO: Concentration in ppm
DNA: Data not available

Table 2.8. Data on Trend of Population, Area, and Density of Dhaka Mega City

Year	Area (Sq. Km)	Population	% Increase of population over the preceding year	Density (Per Sq. Km)
1951	85.45	411,279		4813.09
1961	124.45	718,766	74.764	5775.54
1974	335.79	2,068,353	187.764	6159.66
1981	509.62	3,440,147	66..323	6750.41
1991	1352.82	6,844,131	98.949	5059.16
2001	1352.82	10,712,206	56.517	7918.43
2005*	1352.82	13,133,878	56.517	9708.52

Source: BBS, 1991 & 2001
*Note: * Estimated based on decadal growth rate of 1991-2001*

Table 3.2: Year wise data on the Registration of Motor Vehicles in Dhaka (Up to 2005).

SL. No.	Type of Vehicles	Before 1995	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Total
1	Motor car	36998	6923	8386	6528	4984	4330	2452	5560	5542	6163	4734	5633	98233
2	Jeep/St. Wagon/ Microbus	17937	1556	1387	1492	1438	1371	910	1579	2911	1810	2114	3303	37808
3	Taxi	787	25	35	14	102	215	348	762	2101	4980	523	514	10406
4	Bus	269	145	73	58	184	224	202	453	632	374	779	728	4121s
5	Minibus	2009	324	167	397	300	215	242	831	1924	1051	368	118	7946
6	Truck	9775	802	615	834	1681	855	1635	890	1127	2128	1437	1104	22883
7	Auto-rickshaw/ Tempo	8359	7301	4615	1902	1689	682	1881	75	2616	7996	2344	139	39599
8	Human Haller	*	*	*	*	*	*	*	*	*	673	136	20	829
9	Covered Van	**	**	**	**	**	**	**	**	**	**	527	**	527
10	Motor-cycle	61478	4427	4027	5346	4992	5330	8768	8590	9102	7239	7872	12879	140050
11	Others	2063	878	828	310	196	1326	819	1825	1012	3257	1300	2361	16175
	Total	139675	22381	20133	16881	15566	14548	17257	20565	26967	35671	22134	26799	373077

Source: BRTA, 2005
* *Human Haullers are included in others row (Sl. No. 11)*
** *Covered Van are included in others row (Sl. No.11)*