CHAPTER 1

INTRODUCTION

1.1 Research background

Rivers are integral component of the Earth’s freshwater resources. They play a vital role not only in the water cycle but also in sustaining human life and in supporting terrestrial ecosystems (Shiklomanov 2000). Consequently, there is an utmost importance to protect river water from pollution and degradation for the purpose of maintaining ecological, economic and social sustainability (WCED 1987; Birkeland 2002; Baker 2006). However, rapid urban population growth and industrialisation are putting severe strains on the quality of fresh water resources (UNDSD 1992). In many cases the ecological importance of rivers has been neglected or sacrificed, while focusing on the economic growth of the region. In recent years the pollution of river water has drawn much attention worldwide and contamination of such fresh water resources is being considered as one of the main problems to overcome in the 21st century (Cosgrove and Rijsberman 2000). It is recognised as a key task in this century to maintain a balance between the increasing human needs and the quality of the fresh water resources as identified by the World Assessment Program:

‘We are in the midst of a water crisis that has many faces. Whether concerning issues of health or sanitation, environment or cities, food, industry or energy production, the twenty first century is the century in which the overriding problem is one of water quality and management’ (UN World Water Development Report 2003, p.4).

One of the important achievements of the Earth Summit held in Rio de Janeiro in 1992 was the unison of the world leaders to conserve the precious resource of freshwater. Chapter 18 of Agenda 21 sees ‘effective water pollution prevention and control’ programs as vital elements of sustaining national development plans (UNDSD 1992). The Dublin Statement (Young et al. 1994) also reiterated that fresh water is a finite resource and should be considered to be an economic good. This statement eventually led to
international efforts that emphasised integrating water use and sustainable development, and the need to manage this natural resource with an integrated approach (Vo 2007).

Bangladesh is a land of many rivers that are considered as the lifeline of this country. The daily livelihoods of millions of people in Bangladesh in terms of transportation, agricultural and fishing practices are directly dependent on the healthy existence of rivers. Moreover, rivers are treated as major sources of drinking water and an inseparable part of the ecosystem. The trend of urbanisation and industrialisation near these rivers has helped the economy of the country to grow over the years, but it has resulted in heavy pollution of many rivers and other water bodies (Gain et al. 1998). Studies show that in recent years contamination has seriously degraded the water quality of many rivers, thereby restraining access to safe water resources to many Bangladeshis (DWASA 1998; Magumdar 2005).

The pollution problem of the rivers in Bangladesh is complex because of its multidimensional nature. There are social, economic and environmental dimensions related to water pollution management issues that need to be jointly addressed while seeking a sustainable solution (UNDSD 1992). Sustainable management approaches have been lacking in Bangladesh as environmental protection activities come second to more demanding priorities such as alleviation of poverty, health care, basic educational needs—all related to insufficiency of resources. Bangladesh needs a system of river pollution control, which should be effective not only in terms of environmental protection but also in terms of economic feasibility and social acceptability.

### 1.2 Statement of the problem

The Buriganga River, which encompasses south-western periphery of Dhaka City, is a typical case of surface water pollution in Bangladesh. A number of earlier studies (Ahmed and Mohammed 1988; DOE 1993; Rahman and Rana 1995; Kamal 1996; Reazuddin and Akhteruzzaman 1998) have analysed the pollution problem of this river. Although there are variations in the findings among these studies, they have all expressed concern about the deteriorating condition of the Buriganga River. However, the lapse of time outlines the need for a more recent study to be conducted to update information on the present state of river water quality. The previous studies mainly focused on the
measurements of river water quality, but only horizontally near the discharge points and also did not cover the temporal (seasonal) variation of river water quality. Moreover, statistical validity of the quantitative measurements of the water quality parameters was not conducted to clarify the state of water quality and pollution along the river. The updated information on water quality parameters is also essential for the purpose of examining and evaluating the cost-effectiveness of alternative pollution abatement policy instruments.

Previous studies on the Buriganga River also provided various recommendations for pollution control measures of this river. These include control of pollutants through set up of common or individual effluent treatment plants (BKH 1995); augmentation of river flow through the construction of river water diversion structures (IWM 2004a); and relocation of the pollution causing industries (Rahman and Rana 1996). All of these measures rely on expensive engineering based solutions. These approaches may meet regulatory requirements for the time being but will not be able to control the pollution in a sustainable manner—as these measures simply shift the pollutants around, change their form, or delay their release into the environment (Barbier 1987; Davies and Mazurek 1999; Rotmans and Asselt 2000).

The existing pollution control regulations in Bangladesh consist mainly of command and control (CAC) based regulations (Marr and Dasgupta 2009). However, in many countries the application of economic incentive (EI) based instruments are becoming popular as an alternative pollution control policy. There are reports that several Organisation for Economic Co-operation and Development (OECD) countries like the USA, Australia and the EU have shifted to EI based policies instead of, or alongside CAC based policies to have a better system of pollution control (Bernstein 1993; Howe 1994; Henderson and Norris 2008). These alternative policies have also been introduced in some developing countries, particularly in Latin America and East Asia (Panayotou 1993; World Bank Group 1999).

The EI based policy approaches are more flexible, efficient and cost-effective for pollution control in many cases. However, there are arguments regarding the selection of suitable pollution control policy instruments particularly in the context of a developing county (Russel and Vaughan 2003). The applicability of such EI based policy measures in
Bangladesh has not yet been empirically examined (Marr and Dasgupta 2009). Moreover, appropriate decision support tools to assess and compare the efficiency and cost effectiveness of EI based instruments with CAC based instruments in Bangladesh context are not currently existent. This creates an important gap in the knowledge on applicability of EI based instruments to river pollution management system in Bangladesh.

Baumol and Oates (1995) argued that in practice neither CAC nor EI based measures alone constitute an optimal regulatory strategy for pollution control. They point out that a mixed policy consisting of EI and CAC based regulations could be the most effective strategy to realise a given environmental standards. The World Bank (2000) has further stressed the role of local communities along with Governments and economic instruments for pollution control purpose. This points to a need for a new integrated concept of pollution management for fresh water resources where the importance of state, community and economy has been recognised (UNDSD 1992; Henderson and Norris 2008).

This new concept is set within a paradigm for water pollution management that favours the multi-dimensional nature of integrative solutions (Biswas et al. 2005). Recently in Bangladesh a number of community based and civil society organisations have shown their interest and concern in river pollution control (BAPA 2005; Channel I and Daily Star 2009). This is a positive sign towards the idea of applying multi-stakeholder based and integrated pollution control system in this country. However, the provisions for inclusion of EI based instruments and the involvement of different stakeholders for such integrated approach within the present regulatory measures are not clear.

The pollution of Buriganga River has become a growing concern for the public at large and for the Government of Bangladesh. A high powered River Pollution Mitigation Committee (RPMC) has been formed by the Government who has recently proposed an action plan to mitigate the pollution of rivers flowing around Dhaka, including Buriganga (RPMC 2008). The action plan is composed of 38 components which are to be implemented in short, mid and long term with specific outcomes and time frames. However, the proposed action plan for water pollution management follows a piecemeal approach and lacks integration of alternative EI based policies and multi-stakeholders’ participation.
This PhD research project is designed to conduct an analysis to examine the possibility of application of an integrated approach and to formulate improved management options for the Buriganga River. The expected outcome from this research is to demonstrate a comparison of cost effectiveness for pollution abatement between current and alternative policy mechanisms and to provide recommendations for application of an integrated management framework to control water pollution in the Buriganga River. It is expected that such an approach will be consistent with maintaining the economic growth while ensuring social well being and environmental protection in the study area.

1.3 Aim and objectives of the research

This research project aims to develop a sustainable management system to control the impact of wastewater in the Buriganga River in Bangladesh. In order to accomplish the aim of this project, the thesis has the following specific objectives:

1. To assess the water quality in the Buriganga River by quantitative determination of the selected parameters and understand their temporal (seasonal) and spatial dynamics.
2. To assess the quality of wastewater and pollution loading discharged into the Buriganga River in terms of selected parameters.
3. To evaluate the existing system for river pollution control in Bangladesh.
4. To determine the economic costs that are likely to result under alternative policy instruments for pollution reduction, such as, uniform reduction, uniform taxes and tradable permit system.
5. To recommend a conceptual framework for the application of an integrated management system for protection of water quality of the Buriganga River.
1.4 Components of the research project

The objectives/tasks of this project were pursued according to a research plan (Figure 1.1). The plan was developed by conducting reconnaissance survey, revision of existing documents and in consultation with relevant staff and personnel in river water quality management in Bangladesh. The activities as shown in the plan demonstrate the scope of the research study and will be discussed in the following chapters.

An interdisciplinary research (Slocombe 1993; Pickett et al. 1994; Jonsson et al. 2003) was designed to accomplish the project aim and objectives. This is a problem solving approach that transcends the periphery of academic disciplines or schools of thought ‘to redefine problems outside of normal boundaries and reach solutions based on a new understanding of complex situations’ (Ausburg 2006). This approach was required for the purpose of designing an integrated management framework to control the pollution in the Buriganga River. Jakeman et al. (2006) suggest that knowledge, skills and methods from wide range of disciplines such as economics, environmental sciences, sociology and engineering should be gathered in order to formulate an integrated approach.

The concept of an integrated approach may have different meanings and interpretations. Rotmans (1998) defines the concept as ‘an interdisciplinary process of combining, interpreting and communicating knowledge from diverse scientific disciplines in such a way that insights are made available to decision-makers’.

Afsah et al. (1996) has suggested a model for an integrated approach to reduce pollution, where the role of multiple stakeholders has been recognised. This model has replaced the traditional view of regulation, which focuses exclusively on interactions between the government and the polluters, with a multiple stakeholder based approach. In this new paradigm the role of the government regulators extends beyond monitoring the state of water quality and enforcing rules and standards. It also includes negotiating and promoting non-traditional policy approaches such as taxes, permits, public disclosure, community monitoring etc. which harness the power of markets and society. However, it is obvious that the optimal combination of such policy instruments for pollution control will depend on case specific environmental, socio-economic and institutional conditions.
Project Aim:
Formulating an integrated approach to control pollution in the river Buriganga

Task 1:
Assessment of present state of river water quality and pollution

Activities:
1. River hydrological characteristics
2. Concentration of pollutants both at receptor and discharge points (temperature, pH, ECw, DO, BOD₅, COD, PO₄-P, NH₃-N, Pb and Cr)
3. Pollution loading rates in terms of BOD₅
4. DO transfer coefficients for discharge-receptor pairs

Task 2:
Assessment of present system for pollution control

Activities:
1. Provisions within national policies
2. Legislative framework
3. Organisational capacity
4. Enforcement status of regulations
5. Scope of public participation for pollution control

Task 3:
Assessment of cost-effective abatement policy for organic wastes (BOD₅)

Activities:
1. Total abatement costs at different sources
2. Spreadsheet based simulation model
3. Economic assessment of alternative policies:
   - uniform reduction
   - uniform taxes
   - tradable permits

Research Outcome:
Facilitate the application of an integrated management system

Recommendations:
1. Conceptual framework of the system
2. Required policies
3. Outlining the roles of stakeholders

Figure 1.1. Components of the research project
1.5 Thesis structure

This thesis comprises eight chapters. Chapter 1 provides a general introduction to the research problem including background, objectives and research components. Chapter 2 discusses the relevant literature and information on the environmental significance of water quality parameters with a focus on impact of pollution in the river. Moreover, the chapter looks and re-examines the current state of knowledge on available policy options for river pollution management.

Chapters 3 and 4 cover Task 1 (Figure 1.1) of this research. Chapter 3 provides background information on the study area in terms of hydrodynamic features of the river system, climatic condition, drainage system, socio-economic condition, usefulness of the river and sources and causes of pollution in the river. It also critically reviews the findings of previous studies on water quality and pollution management for this river. Chapter 4 describes the methodology and the findings on the current state of water quality and pollution in the Buriganga River. It discusses the quantitative and the analytical results on the selected water quality parameters with temporal and spatial variations. Moreover, it looks at the assessment results for the wastewater quality parameters, flow rates of wastewater and pollution loading rates in terms of organic wastes at the discharge points of the river. It also provides calculation results for the dissolved oxygen transfer coefficients, and deoxygenation and reaeration rate coefficients.

Chapter 5 covers Task 2 of this research. This chapter discusses the performance of the present system in terms of several aspects such as relevant national policies, legislative framework, organisational capacity, and monitoring and enforcement status. It also looks at the scope of community participation for pollution control by reviewing their capacity and willingness for contribution.

Chapter 6 includes Task 3 of this research. It describes the methodology of model development for economic assessment of alternative pollution control policies for the Buriganga River. It also discusses spreadsheet analysis results from simulation exercise of alternative abatement policies. Chapter 7 incorporates discussion on experience of river pollution management from six different case studies. Further, based on all the findings of this research, this chapter proposes a conceptual framework of an integrated pollution
management system for the Buriganga River and identifies the roles of stakeholders and suggests a set of policy initiatives for implementing such a system in Bangladesh context. Finally, Chapter 8 provides conclusions on the overall findings from this research, identifies limitations of this study and includes suggested areas for future research on river pollution management.