CLEANUP OF THE BURIGANGA RIVER

INTEGRATING THE ENVIRONMENT INTO DECISION MAKING

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This thesis is presented for the degree of Doctor of Philosophy

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I declare that this thesis is my own account of my research and contains as its main content work which has not previously been submitted for a degree at any tertiary institution.

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Abstract

This research attempts to fill in some specific gaps in the area of economic valuation of non-market goods and services with respect to development projects, and the integration of those values in the policy decision-making process. The concept and theory of non-market valuation and project appraisal are examined. In a developing country context, the conventional contingent valuation method is extended to include respondents' contribution in terms of time, irrespective of their decision to contribute money. This extension of the conventional contingent valuation method allows the inclusion of economic activities that are non-monetized and transactions in the form of 'barter exchange', which are typical for developing countries such as Bangladesh. The values generated by this new approach are integrated into an extended cost-benefit analysis, which reveals that the cleanup of dying rivers is not only an environmental imperative, but is also socially and economically justifiable. Apart from the theoretical investigation, another important dimension of this research is to contribute to the policy decision-making process with regard to public sector investment in developing countries.

The Buriganga River, which passes through Dhaka City, the capital of Bangladesh, has been selected as the case study for this research. Although considered to be the lifeline of the capital, the city part of the Buriganga River has become biologically and hydrologically dead because of the indiscriminate dumping of domestic and industrial wastes, encroachment by unscrupulous people, and negligence on the part of the authority to enforce rules and regulations pertaining to the ecological health of the river. A cleanup programme has been designed for the Buriganga River to restore its water quality and develop new facilities in and around the river. This hypothetical cleanup programme is used: (i) to estimate the non-market benefits of an environmentally healthy waterway; (ii) to measure the total benefits; and (iii) to examine the desirability of public funding for the cleanup programme.

An extended contingent valuation (ECV) survey of 400 households was carried out in Dhaka City in 2001. It reveals that not only are a significant proportion of the respondents willing to contribute direct cash for the environmental improvement of the river, they are also willing to contribute their time. When the contribution in terms of

time is monetized, it is estimated to represent about 60 percent of the total contribution (the remaining 40 percent being cash payment).

The total non-market benefits from the Buriganga River cleanup programme are estimated at Tk 388 million (US$ 6.80 million) in the first year, rising to Tk 1805 million (US$ 31.66 million) by the 10th year of the programme. The public decision-making process in Bangladesh does not consider such benefits. Failures to do so lead to gross under-estimation of the potential for, and contribution of, undertaking environmental improvement activities.

The total benefits of the cleanup programme are estimated within the framework of total economic value: the non-market benefits are estimated using the ECV survey inputs, and the market benefits are measured using secondary information, market methods and a benefit transfer approach. The cost estimate of the cleanup programme is made using market and secondary information with appropriate adjustments. The extended cost-benefit analysis (ECBA), which integrates the non-market benefits of the cleanup programme, shows that such public funding is worth undertaking. The study also reveals that a significant portion (68 percent) of this investable funding can be generated from the community.

The need for a cleanup programme of the Buriganga River is not an isolated case in Bangladesh. Many rivers in that country, and also throughout the developed and developing world are under threat of becoming biologically and hydrologically dead. This study provides a framework for addressing such environmental problems. It demonstrates that the ECV survey is a useful tool in estimating economic values of resources even in extremely poor economies. The modification of the contingent valuation method takes into account the local context, including cultural, economic, social and political settings. The extended cost-benefit analysis, which integrates better resource values could provide important information for the policy decision-making process. This is particularly useful for countries where the democratic system is not fully developed and there is limited experience in integrating the environment into the decision making.

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This work is dedicated with love to my wife Laila Alam (Shibu) and to my daughter, my spirit of inspiration, Fariha Alam.

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Explanatory notes to the tables

- Details and percentages do not necessarily add up to totals, because of rounding.
- The term ‘dollar’ ($) refers to US dollar, unless otherwise stated.
- 1 Crore = 100 Lakhs = 10 Million = 0.01 Billion
- Fiscal year (FY) is from July 1 to June 30 which is referred to as 2001/2002 meaning July 01, 2001 to June 30, 2002. Calender year is referred to as 2001 meaning January 01, 2001 to December 31, 2001.
- In all cases the data referred to MOF (2001) for 2000/2001 are estimated.
- During the period of the survey, the official exchange rate of the Bangladesh currency (Taka) on June 30, 2001 was Tk 57.00 per US dollar (US$). Therefore, US$ 1 = Tk 57.00 or Tk 1 = US$ 0.0175 is used as currency conversion in this study.

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Abbreviations and Acronyms

ADB	Asian Development Bank
ADOF	Australian Department of Finance
ADP	Annual Development Programme
BAPA	Bangladesh Poribesh Andolon (Bangladesh Environmental Movement)
BBS	Bangladesh Bureau of Statistics
BCAS	Bangladesh Centre for Advanced Studies
BCR	Benefit-cost ratio
BELA	Bangladesh Environment Lawyers' Association
BIWTA	Bangladesh Inland Water Transport Authority
BOD	Biochemical oxygen demand
BRA	Buriganga River area
BRCP	Buriganga River cleanup programme
BUP	Bangladesh Unnayan Parishad (Bangladesh Development Forum)
BV	Bequest value
BWDB	Bangladesh Water Development Board
CBA	Cost-benefit analysis
CBO	Community-based organization
CETP	Common effluent treatment plant
COD	Chemical oxygen demand
CPI	Consumer price index
CS	Consumer surplus
CV	Contingent valuation
CVM	Contingent valuation method
DA	District Administration
DC	Dichotomous choice
DCC	Dhaka City Corporation
DDRA	Dhaka District Revenue Administration
DO	Dissolved oxygen
DOE	Department of Environment
DND	Dhaka-Narayanganj-Demra
DPHE	Department of Public Health Engineering
DUV	Direct use value
DWASA	Dhaka Water and Sewerage Authority
EC	Electrical conductivity
ECA	Environmental Conservation Act
ECBA	Extended cost-benefit analysis
ECNEC	Executive Committee of the National Economic Council
ECR	Environmental Conservation Rules

ECV	Extended contingent valuation
ECVM	Extended contingent valuation method
EGIS	Environment and Geographical Information Service
EIA	Environmental impact assessment
EQS	Environmental quality standard
EV	Existence value
FAP	Flood Action Plan
FCDI	Flood control, drainage and irrigation
FGDs	Focus group discussions
GAP	Ganga (Ganges) Action Plan
GBM	Ganges-Brahmaputra-Meghna
GDP	Gross domestic product
GO	Government
GOB	Government of Bangladesh
ha	Hectare
HPM	Hedonic price method
IADB	Inter-American Development Bank
ICTP	International Conventions, Treaties and Protocols
IRR	Internal Rate of Return
IS	Interview schedule
IUV	Indirect use Value
kg	Kilogram
km	Kilometre
LGED	Local Government Engineering Department
m	Metre
m^2	Square metre
m^3	Cubic metre
m^3/s	Cubic metre per second
mg/l	Milligram per litre
MLD	Million litres per day
MLGRDC	Ministry of Local Government, Rural Development and Cooperatives
mm	Millimetre
MOE	Ministry of Establishment
MOEF	Ministry of Environment and Forest
MOF	Ministry of Finance
MOI	Ministry of Industries
MOL	Ministry of Land
MOS	Ministry of Shipping
MOW	Ministry of Works
MOWR	Ministry of Water Resources
NGOs	Non-government organizations
NOAA	National Oceanic and Atmospheric Administration

NPS Non-point source
NPV Net present value
NUV Non-use value
NWP National Water Policy
OBA Outside Buriganga River area
ODA Overseas Development Administration
OE Open-ended
OECD Organization for Economic Co-operation and Development
O&M Operation and maintenance
OV Option value
PC Planning Commission
PCP Project concept paper
PD Planning Division
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PER Public Expenditure Review
POROSH Poribesh Rakha Shopot (Pledge to Protect Environment)
PP Project proforma
PPI Potential Pareto Improvement
ppm Parts per million
PS Point source
PV Present value
RAJUK Rajdhani Unnayan Kartripakkya (Capital City Development Authority)
RRI River Research Institute
SKS Sena Kalyan Sangstha (Army Welfare Organization)
SMA Statistical Metropolitan Area
SP Shadow price
SSRC Social Science Research Council
sq km Square kilometre
SWMC Surface Water Modelling Centre
SWTP Saidabad Water Treatment Plant
TCF Trillion cubic feet
TCM Travel cost method
TDS Total dissolved solid
TEV Total economic value
Tk Taka (Bangladesh currency)
TWTC Total willingness to contribute
USACE United States Army Corps of Engineers
UV Use value
UNIDO United Nations Industrial Development Organization
WARPO Water Resource Planning Organization
WASA Water and Sewerage Authority
WB World Bank
WC Waste Concern
WTA Willingness to accept

WTC_T	Willingness to contribute time
WTP	Willingness to pay
WTC_M	Willingness to contribute money
$\chi 2$	Chi-square

Glossary of Bengali Words

Abarjona O Poribesh	Waste and Environment
Badia and Bede	Itinerants who move from place to place in search of work as hunters, snake-charmers and folk healers
Bandh	Embankment
Bangladesh Poribesh Andolon (BAPA)	Bangladesh Environmental Movement (a forum of citizens and organizations concerned with the environment of Bangladesh)
Beel	Small lake or low-lying depression which generally retains water throughout the year
Buriganga Bachao Andolon	Save the Buriganga Movement (a sub-committee of the BAPA trying to mobilize public support to save the Buriganga River and create pressure on the regulatory authorities)
Char	Shoal or sandbar (newly-emerged land in a river channel)
Crore	Unit of measurement, 1 crore = 10 million
Hats and bazaars	Small and large market places (permanent or temporary)
Kaucha bazaar	Temporary or permanent market place mainly for selling fruits, vegetables and groceries
Khal	Local name for canal or water channel
Khas	Government-owned unallocated land
Lakh	Unit of measurement, 1 lakh = 0.01 million
Madrashas	Muslim religious educational institutions
Mohalla	Suburb consisting one or more streets
POROSH	Poribesh Rakha Shopot (Pledge to Protect Environment)
PROSHIKA	It is an acronym of three Bengali words, which stand for training (proshikkhan), education (shikkha) and action (karmo) and one of the largest NGOs in Bangladesh
RAJUK	Rajdhani Unnayan Kartripakkya (Capital City Development Authority)
Semi-pucca	A building of mixed construction with at least some brick and mortar
SKS	Sena Kalyan Sangstha (Army Welfare Organization)
Shishu Park	Children’s Park
Taka (Tk)	Bangladesh currency
Thana	The lowest administrative but intermediate local government unit where central government bureaucracy works (formerly known as Upazila)
Ward	Lowest local government unit
Zila	District (main sub-regional administrative unit in Bangladesh)

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Chapter One
INTRODUCTION AND COVERAGE OF THE STUDY

1.0 Introduction

Developing countries are ravaged by many environmental problems, such as air and water pollution, land degradation, loss of biodiversity and sea level rise. These problems are also common to developed countries and some have transcended national boundaries. The market mechanism has failed to prevent or cope with many of these environmental problems. Negative externalities, i.e. situations in which the consumption or production activities of one individual or firm negatively affect another person, a firm's production or the physical environment (Hanley *et al.,* 1997), are particularly relevant to environmental problems. In particular, negative externalities often cause damage to the environment. For instance, exhausts from the increased number of automobiles aimed at improving the transport service can contribute to air pollution and thus pose the risk of health hazards to residents. When such externalities exist, the market will not necessarily result in an efficient allocation for maintaining natural resources and improving environmental quality. Social institutions other than the market, such as government intervention, need to act in order to improve efficiency. Government interventions, aimed at fixing the malfunctioning of markets, can take the form of a development project, programme or policy formulation on the part of local, regional or national authorities.

Government interventions, whether projects, programmes or policy making, are expected to generate both market and non-market benefits. Market benefits are those kinds of benefits which have established markets or are exchanged through markets and thus have a price tag, while non-market benefits are the kind of benefits which do not have any established market and thus do not bear any price[1]. The term non-market is used to cover a wide range of situations wherein "markets are nonexistent, incomplete or institutionally restrained from reflecting interaction between supply and demand" (ADB, 1999a: 17). The concept, however, does not imply that the market has nothing to do with the goods and services in question. The market may provide information, but it

1 These benefits are also referred to as non-priced benefits (Tyrväinen, 2001).

is likely to be incomplete or indirect. In such cases, the market will not reflect, if at all, the true value of the good or service. Shechter (2000) also distinguishes non-market benefits from conventional market benefits in that "their [non-market benefits'] use does not always involve market transactions. Consequently, explicit market-determined valuation, that is prices, usually does not exist for them" (p: 72).

Most importantly, many of the non-market benefits are not accounted for in the decision-making process, particularly in many developing countries such as Bangladesh. The non-monetization of such benefits may mean that they are either under-valued or over-valued in the intuitive decision-making process. Thus, a failure to account for such benefits could lead to a misallocation of public investment. Quite often restoration of ecosystems, preservation of natural resources and development of degraded environmental resources bear the consequences.

Developing countries are engaging in development activities often as a requirement of international organizations as well as domestic governments. Although the issue addressed in this study is in the context of Bangladesh, it has implications for any country. The issue of monetization of non-market goods and services and their integration into the decision-making process is a general one, common to a wide range of countries, including developed ones. In this study, these issues are examined in a specific case, the cleanup of a heavily polluted and dying river, named the Buriganga, which flows through Dhaka, the capital of Bangladesh. This study is not an isolated examination of a particular river, rather it presents an integrated approach to vulnerable rivers and fragile natural ecosystems, and to the integration of non-market resources into the decision-making process. The topic being investigated goes beyond one particular country, namely Bangladesh and one particular case, namely the cleanup of a dying river. It is an attempt to develop a theoretically sound methodology and apply it in the case study of Bangladesh.

The theoretical underpinning of the valuation method and economic analysis is based on neo-classical welfare economics. This is not because it is infallible or beyond any controversy, but because it is the ruling paradigm among both academics and practitioners[2]. Therefore, a more workable model of estimating the benefits of non-market goods and services could be integrated into the decision-making process and, thus, contribute to knowledge and policy-making fields.

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[2] More is described in *Chapter Three.*

This chapter introduces the state of public sector investment and outlines decision-making scenarios in Bangladesh, identifies gaps in the decision-making process, states the research questions and objectives, and frames the scope of the research. The aim is to introduce the researched problem both from a theoretical perspective and in terms of policy implications.

1.1 Public Sector Investment and Decision Making in Bangladesh

Bangladesh is one of the poorest countries in the world with a population of 129 million in an area of 147,570 square kilometres (834 persons per square kilometre) and a per capita annual income of only US$ 387[3] (MOF, 2001 and BBS, 2001). Since gaining independence from the then West Pakistan in 1971, there have been more than three decades of development efforts aimed at lifting the economy out of abject poverty.

Economic development in Bangladesh is mainly triggered by concentrated efforts through new investments. As a result, the total investment to gross domestic product (GDP) ratio has increased from 14.60 percent in 1980/81 to 16.90 percent in 1990/91 and to 23.63 percent in 2000/01 (Alam, 1998 and MOF, 2001). However, in 2000, the country still had one of the lowest investment/GDP ratios in the Asian region. For example, the ratio in India was 24 percent, Sri Lanka 25 percent, Thailand 41 percent, Singapore 33 percent, Malaysia 32 percent and China 40 percent (WB, 2000). The history of economic development in Bangladesh reveals that major development efforts have come through public investment, although the share of public investment to total investment has declined in recent years with private investment increasing to fill in the gap.

As a result of economic reform measures undertaken since the mid-1980s to stimulate a private sector-led market economy in Bangladesh, private investment has increased due to increases in foreign direct investment and local financing (domestic saving). As a percentage of GDP, public investment increased from 6.63 in 1990/91 to 7.91 in 2000/01, while private investment grew from 10.27 to 15.72 during the same period (MOF, 2001). Furthermore, investment in absolute terms has also increased. Total investment grew from Tk 171,102 million in 1990 to Tk 540,812 million in 2000 while private and public investments increased from Tk 98,426 million and Tk 72,676 million to Tk 378,422 million and Tk 162,390 million respectively during the same

[3] US$ 1.00 = Tk 57.00 (as in June, 2001). The term 'dollar' ($) refers to US dollar throughout this thesis, unless otherwise stated.

period (BBS, 2000). Although the share of public investment to total investment showed a declining trend (from 42.48 percent in 1990 to 30.03 percent in 2000), public investment increased by 123 percent in absolute terms from 1990 to 2000. With the increasing share of public investment to GDP, the importance of public funds for faster economic growth and socio-economic upliftment is still pivotal.

Over the years, some areas of the economy have been able to attract private investment because they have tangible, marketed and commercially viable outputs. These areas are road transport, urban housing and ready-made garments. Many other areas of the economy are yet to attract private investment, such as physical infrastructure (e.g. rural housing), agro-process and agro-based industries, rural industries and telecommunications, afforestation, transport and communications (e.g. rural transport, rail and inland waterways), investment in under-developed areas and so on. Due to the lack of private investment on the one hand and the importance of some sectors, such as education (mainly mass, primary and tertiary), human resource development, community health, water supply and sanitation and research (e.g. agriculture and industry), for the overall economic development of the country on the other hand, the commitment of public investment for these sectors is likely to continue in the future.

Being a poor developing country, the constitutional obligations of the State require measures for raising the standards of living of all citizens of the country. Therefore, Bangladesh attaches due importance to the appropriate role of public sector investment in areas such as poverty alleviation, creating employment opportunities, environmental quality improvements (e.g. air and water), flood control and drainage, construction of river bridges, protecting river-banks from erosion, rural development and electrification, governance, development for vulnerable groups, disaster management, social welfare, women's development and family planning. The Fifth Five Year Plan (1997-2002) elaborates that "public investment will mainly be directed for expansion of public utilities like power and gas, development of physical infrastructure like roads and embankments, expansion of social infrastructures like health and education, alleviation of poverty and strengthening of public administration for efficient response to the need of market economy. However, some public investment in productive enterprises will be necessary where [the] private sector may not be forthcoming to a desirable extent" (PC, 1998: 53).

Thus, development projects in the public sector play a vital role in the socio-economic development of the country. They are considered to be a potent instrument of government intervention for mitigating market and policy failures. They provide public goods and services, and institutional support. Public investments in the form of development projects and programmes[4] are supposed to bring significant economic and social benefits, through alleviating poverty, creating employment opportunities, improving environmental quality and generating goods and services.

Due to the importance of public sector investment, the efficiency of the Bangladesh economy depends to a critical extent on the performance of development projects. The general notion is that the government should provide services through investment projects as private investment is not feasible in many areas and/or households are considered too poor to pay for such investment. Despite many changes in economic policy and management, the role of public sector development projects is expected to remain very important in the foreseeable future.

Public sector investment in Bangladesh works within a medium term framework, that is five years. Since 1973, the Bangladesh Government has implemented one two-year plan and five five-year plans[5]. A five-year development plan is, in principle, a flexible guideline of economic policies and strategies. The Annual Development Programme (ADP) is the operational instrument for translating the planned objectives into time-bound projects or programmes. In other words, well-prepared ADPs and properly executed development projects/programmes are the cornerstone for the success of a development (five-year) plan. The ADP consists of projects in the public sector under different sub-sectors, ministries, divisions and agencies in a particular fiscal year (i.e. between July 1 and June 30), and is the operational document of a five-year plan in respect to the public sector.

Table 1.1: *Public sector project portfolio for 1999/2000*

Sub-sectors	Sponsoring ministries/ divisions	Imple-menting agencies	No. of projects			Project cost (Billion Taka)			
			Investment	TA	Total	Local	PA	Total	As % of GDP
17	36	144	1067	163	1293*	79.65	62.96	142.61	8.15

[4] In this study, the terms project and programme are used interchangeably in spite of the differences between them (projects tend to be more specific and confined to the short term, while programmes are broad-based and more continuous in nature).

[5] The implementation of the Fifth Five Year Plan (1998-2002) has completed in 2002. The Sixth Five Year Plan (2003-7) is now under preparation.

Notes: * Included in the total are 56 self-financed and 7 food-assisted projects.
TA- Technical assistance; PA- Project aid.
Source: Compiled from PC (1999).

Table 1.1 shows the public sector's project portfolio for the 1999/2000 fiscal year. It is divided into 17 different sub-sectors; these are: agriculture; rural development and institutions; industry; water resources; energy; oil, gas and mineral resources; transport; communication; physical planning and water supply; education and religious affairs; sports and culture; health, population and family welfare; mass media; social welfare, women and youth development; labour and manpower; public administration and science and technology. These projects are sponsored by 36 ministries or divisions, and 144 agencies are responsible for their implementation[6]. After receiving a project from an agency through the concerned ministry/division, the Planning Commission processes the project for approval. If a project costs less than Tk 10 crore (100 million[7]), then the Minister in charge of the Ministry of Planning approves the project. In the case of projects which cost Tk 10 crore or more, the Executive Committee of the National Economic Council (ECNEC) approves the project[8].

Table 1.1 also shows that 1293 projects were included in the 1999/2000 ADP. Of these projects, 1067 are investment (i.e. projects aiming to generate revenue, employment and goods and services; and these can be financed by domestic resource and/or foreign aid); 163 are technical assistance (i.e. projects aiming to transfer technology and skill from a donor country/agency to recipient country in the form of feasibility studies and pilot/demonstration projects, and financed by donors); 56 are self-financed by parastatals (i.e. financed through resources generated by autonomous and semi-autonomous organizations); and seven are food-assisted (sale proceeds of food aid which is used for various agricultural, water management, rural development and infrastructure, food for education and food for works programmes) projects. The total cost at current prices is estimated at Tk 142.61 billion which is about 8.15 percent of the country's GDP. Out of the total ADP outlay for 1999/2000, Tk 79.65 billion (55.85 percent) were projected to come from domestic resources and Tk 62.96 billion (44.15 percent) from project aid (i.e. official development assistance received in relation to projects/programmes through bilateral and multilateral agreements).

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[6] Some projects are directly implemented by ministries or divisions.

[7] 1 million = 10 lakh = 0.10 crore

[8] The Prime Minister is the chairperson of the ECNEC and all cabinet ministers are members.

The allocation of funds to ADPs in Bangladesh has increased over the years, both in nominal and real terms. As the public sector is still an important player in the socio-economic development of the country, the role of ADPs will continue to be significant in the future. The allocations of the ADPs in gross terms (current price) and as a percent of GDP between 1990/91 and 2000/01 are presented in Table 1.2. It shows that over the last decade total allocation for ADPs has consistently increased. Although, allocation as a percent of GDP ranged between 5.0 in 1991/92 and 6.8 in 2000/01, total allocation in absolute terms increased by 186 percent. This indicates the importance of ADPs for public sector investment in Bangladesh.

The policy decision making in the country's public sector with respect to development projects is based on project appraisal. The main tool used for project appraisal/analysis is cost-benefit analysis (CBA)[9]. It is applied with varying degrees of strictness and as a process of cost minimization. However, the CBA only provides required information in the decision-making process and the selection of a project is a political decision. The use of cost-effectiveness as a criterion for decision making in Bangladesh is very rare.

Table 1.2: *Annual Development Programmes allocation, 1990/91 – 2000/01*

Year	ADP allocation (crore Tk)			ADP allocation as % of GDP
	Total	**Domestic resource**	**Project aid**	
1990/91	6126	2451	3675	5.5
1991/92	7150	3100	4050	5.0
1992/93	8121	3892	4229	5.2
1993/94	9600	5240	4360	6.6
1994/95	11150	6510	4640	6.8
1995/96	10447	5987	4460	6.0
1996/97	11700	6776	4924	6.1
1997/98	12200	7086	5114	5.5
1998/99	14000	8226	5774	5.7
1999/00	16500	9750	6750	6.6
2000/01	17500	10039	7461	6.8

Note: Both ADP allocation and GDP are based on current prices.

Source: Calculated from MOF (2001).

9 The evaluation of the desirability of an investment project is based upon the economic theory and methods referred to as cost-benefit analysis. This process is also called 'social cost-benefit analysis' as it determines whether an investment is socially beneficial (Boardman *et al.,* 1996 and Asafu-Adjaye, 2000). Many use the terms 'economic analysis' (Perkins, 1994) or 'project appraisal' (Curry and Weiss, 1993). Throughout this study, the terms 'cost-benefit analysis', 'economic analysis' or 'project appraisal' are used interchangeably. Furthermore, there is a distinction between economic analysis or CBA, which is carried out from society's perspective, and financial analysis or financial CBA, which is carried out from an individual investor's viewpoint.

There are many cases of project-level distortions or biases against efficient resource use and maintenance of environmental quality. This hinders the achievement of sustainable development. Some of these distortions/limitations are as follows:

- CBA is not being applied to all sectors as it is thought that quantification of environmental impacts and economic valuation of some goods and services produced by the concerned project 'are not possible'. For instance, projects in the social sector[10] are considered not to be amenable to economic analysis as benefits are 'non-quantifiable'.

- In most cases, when CBA is applied, the selection of projects is predominantly based on financial appraisal, that is, on simple cash flow (e.g. projects in the agriculture sector). Less often, the selection is based on narrow economic analysis, that is, narrow in the sense of shadow pricing some inputs and not others (e.g. projects in the energy sector). In other cases, practices of project appraisal mainly focus on cost control or minimization rather than a more professional appraisal using economic techniques (e.g. CBA).

- By and large, aided-projects[11] are appraised with greater rigor and on the basis of the donor's own methodologies. The donor's perspective, however, has least impact on the country's public sector policy making. Projects which are financed exclusively by the government are often prepared and appraised with less technical rigor. As the World Bank put it: "[i]t is not uncommon that the selection of such projects [fully government-financed projects] is influenced by non-economic criteria" (WB, 1996: 59).

Besides involving inadequate application of economic criteria, the decision-making process, I would claim, is often biased due to the failure to appreciate the environmental impacts of development projects; for example:

[10] It is difficult to define a social sector. Often, what is social is also economic and vice-versa. However, for the purpose of convenience, this study follows a conventional definition for social sector adopted in the ADP which includes health, education, religion, sports, culture, population and family planning, communication, social welfare, women and youth development, public administration, science and technology.

[11] Aided-projects comprise both investment and technical assistance projects financed partly or wholly by bilateral or multilateral donor country or aid agency.

- The environmental benefits and costs tend to be too narrowly defined in space and time (normally they exclude externalities and long-term effects) for development projects, regardless of whether they are financed by the government or a donor.

- The environmental effects are not normally considered at the design stage of the project and only in a few cases are environmental impacts described in qualitative terms.

- Neither any scope for nor any attempt to quantify and value environmental impacts in project analysis exists through the existing project appraisal format.

Thus, in the absence of a coherent appraisal methodology, political influence and other non-economic criteria play a key role in policy decision making in Bangladesh. Some of these are described here:

- Since the mid-1980s, the World Bank has occasionally evaluated public investment in Bangladesh under its Public Expenditure Review (PER) programme. Although its main purpose is to scrutinize expenditure and to restrain it, on more than one occasion it identified mismanagement of projects as a major area of concern. The PER-1996 and PER-1997 listed 47 and 91 projects (which is by no means exhaustive) respectively from the 1997 and 1998 ADPs, which "warrant re-examination due to questionable rationale and priorities" (WB, 1996: 40, and WB, 1997: 3). The World Bank also listed a sample of large unapproved projects for which sizable spending had already been committed. It has become a regular phenomenon that every fiscal year the ADP includes a large number of unapproved projects involving the commitment of a sizable amount of funds. The total cost of these projects, sometimes more than a quarter of the total ADP allocation, represents a very large commitment to projects that have not yet been appraised, scrutinized or approved. Once a project is included in the ADP, its subsequent approval has generally been a procedural formality. The probability of dropping ADP-included unapproved projects appears to be rather remote. While some unapproved projects may ultimately deserve to be included in the ADP on the basis of economic analysis, inclusion before approval makes them questionable since they are yet to pass the appraisal stage and prove their merits.

- Pruning of ADPs has become a regular phenomenon[12]. Absence of any set criteria makes both the inclusion and termination of projects more vulnerable to the influence of purely political considerations. It creates an opportunity both for the bureaucrats and the political regime to misuse public funds for 'prestige projects'. These projects are aimed at enhancing the image of the political party in power and its leaders or to provide services to particular constituencies which the concerned bureaucrats/politicians represent. Extensive political interference in choosing projects in the ADP leads to inadequate spending in key areas.

- Another practice is to include new projects in the ADP as 'aided projects', and in many cases the donors are not identified. This potentially leads to the risk that if the effort to obtain donor funding does not succeed, these projects would have to be financed from the Government's domestic resources. The possibility of dropping projects, after including them in the ADP, is practically remote.

The appraisal procedure used to evaluate development projects is inadequate to appreciate the scarcity values and true costs of resources, and does not take these issues into account in the project analysis. The environmental impacts of development projects are largely ignored. This leads to inefficient policy decisions with regard to project selection.

In recent years, the role of project appraisal has also become important due to aid fatigue for developing countries such as Bangladesh. Foreign aid has declined sharply due to: the emergence of some Eastern European and Asian countries in the 'recipient forum', rigid conditionalities, and the poor performance of the Bangladesh economy. The absence of donor vigilance may create more scope for malpractice in project selection. The judicious use of domestic resources requires more sophisticated and reliable project appraisal procedures.

1.2 The Environment in the Decision-making Process in Bangladesh

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[12] After resuming power by the four-party alliance in November 2001, the Planning Commission, under the direction of the new Government, took steps to cut 'unnecessary' and 'superfluous' projects off the current ADP for 'saving scarce resources of the country'. The Planning Commission trimmed the ADP by Tk 3000 crore which is about 15.80 percent of its actual allocation. As it was reported in the press (Ahmed, 2001):

> Mysteriously, the government did not touch two vital heads – Tk 140 crore unallocated block amount and Tk 500 crore block amount – both regarded as good ground to be obliterated from the ADP without touching any real project… Politics played the trick in this regard as the government feels that funds from such block accounts can be easily diverted to politically motivated projects (p:1).

During the 1990s, remarkable progress took place in Bangladesh regarding the formulation of environmental policies and strategies. Much of this development resulted from the signing of different International Conventions, Treaties and Protocols (ICTPs) and overwhelming emphasis on environmental issues by the global community. So far Bangladesh has signed a significant number of ICTPs that include environmental considerations. The country, however, has implemented only few of its obligations under the various ICTPs. Some noteworthy milestones are framing policies and strategies, such as the Environmental Policy 1992, National Environment Management Action Plan 1995, Environment Conservation Act 1995, Environment Conservation Rules (ECR) 1997 and Environment Court 2000. A new ministry named the Ministry of Environment and Forest (MOEF) and an upgraded Department of Environment (DOE) were created in 1989. Despite this, little progress has been made in the area of integrating environmental concerns into development projects.

Two events in the late 1980s created the need for change in Bangladesh. First, after the 1987 and 1988 floods[13], a multi-donor programme called the Flood Action Plan (FAP) was undertaken in coordination with the World Bank. During the FAP studies, a substantial amount of information was generated that impacted variously on water resource development projects, particularly flood control, drainage and irrigation (FCDI) projects. As part of the FAP studies, the *Guideline for Environmental Impact Assessment (EIA)* was prepared in 1992 for use in ongoing and future FAP, similar FCDI and other water management projects. As a companion to the guideline, the *Manual for Environmental Impact Assessment* was prepared in 1995 to cover the technical aspects of EIA. These two documents are the first attempt to identify the environmental impacts of development activities in Bangladesh. They are currently in use for medium and large-scale projects in the water sector. Another manual titled *Guidelines on Environmental Issues Related to Physical Planning* developed by the Local Government Engineering Department in 1994, is being used for small projects undertaken at the local level.

Second, concern for the environment started to mount when development partners raised environmental issues in the course of implementation of various aided development projects. During the early 1990s, particularly after the Rio Summit, many

[13] During the monsoons of 1987 and 1988, Bangladesh suffered two of the most serious floods on record. Vast areas of the country including the capital city were flooded to an unprecedented degree with flood levels about 1.5 meters higher than normal for a period of more than four weeks.

donor agencies started to ask for EIA for their projects. It was essentially the donors who inspired the application of EIA in Bangladesh. The ECR 1997 also made it mandatory for industries in the private sector to have an EIA, and, thus, a clearance from the Department of Environment, before placing a request for approval to relevant departments[14].

Since then, many EIAs have been conducted in Bangladesh, some have been specific to a project and some have been general. The EIA, however, is yet to be incorporated in the formal planning process in the public sector. In 1992, the Government made provision for 'environmental scrutiny' of all development projects, which requires comments from the Ministry of Environment and Forest during the approval process of project proposals. This professional judgement solely is not adequate as there is lack of appropriate knowledge and capabilities to examine environmental consequences (Alam, 1995). A major problem under the existing procedure, is the lack of mandatory provision for environmental assessment. The existing project appraisal formats (Project Proforma or PP and Project Concept Paper or PCP) of the Planning Commission include a question asking for assessment of the environmental impacts of development projects. The common practice is to provide only subjective judgements in reply. The PP and PCP do not require either the identification or the quantification of environmental costs and benefits[15].

The existing assessment procedures are not adequate to examine the impact of a development activity on the environment. In the best case scenario, the environmental impacts of development projects are only described or enumerated in physical terms without monetary values. This leaves the decision-maker with the unenviable task of trying to judge, for example, whether the welfare gains from the project will outweigh the ensuing loss associated with the project. Even with the best intentions, this becomes an intuitive process. If environmental impacts were to be valued in monetary terms, it would be easier for them to receive due and proper weight in the decision-making process.

The non-monetization of environmental impacts means that they are either under-valued or over-valued in the decision-making process. Under-valuation occurs when

[14] Personal communication with the concerned official at the DOE revealed that up to June 2000, 1554 projects and industries received environmental clearance from the DOE.

[15] In most cases, it is stated in the PP/PCP that there will be no adverse effect of the proposed project on the environment; rather it will help to improve the environment.

environmental benefits are given little or no weight, which results in low levels of investment in many areas of the environment. For instance, there was no investment in air quality improvement in Dhaka City until 1999, although many studies described the situation as the worst in the world. Conversely, environmental benefits would be over-valued if environmental considerations are given too much weight by decision-makers, when balancing the unquantified or intangible disbenefits caused by projects against the quantified net benefits estimated in project analysis. A recent tendency has been observed to include an environmental component in a project in order to attract foreign aid or get easy approval. Such projects can divert limited resources to areas that do not provide optimal social, economic and environmental outcomes.

Furthermore, if environmental costs are neglected or ignored, the net benefits of a project tend to be over-valued. For example, traditionally in the case of flood control and irrigation projects in Bangladesh, the costs of the destruction of wetland and floodplain have been ignored against the benefits from increased irrigable land. In the past, many projects have become ‘white elephants’, ‘project failures’, or ‘development disasters’ because of the failure to properly incorporate all the implications for the environment (Alam, 1995 and Haque, 1998).

In addition to non-monetization, the situation is further aggravated when there is a lack of market for the goods[16] generated by the proposed project. All these lead to mis-allocation of resources and, particularly, under-investment in the areas which need urgent intervention from the public fund. For instance, the ADP allocation for the MOEF in 2000/01 was Tk. 26.33 crore which is only about 0.15 percent of total ADP allocation.

There are many areas where benefit estimation or monetization of non-market goods needs urgent attention for efficient allocation of scarce resources in order to facilitate the decision-making process. As already mentioned, trimming of ADPs is a regular phenomenon in the project management in Bangladesh. For instance, the funding for the original ADP in 2001 was proposed to be Tk 19,000 crore, while the revised ADP was set at Tk 16,000 crore, roughly a 16 percent reduction. The downward

[16] The non-marketed output generated/produced by a development project has been named in many ways in the literature: commodities (Lazo *et al.*, 1997), goods (Clinch and Murphy, 1998), environmental assets (Brown and Duffield, 1995), environmental resource (Pearce *et al.,* 1994), non-market resource (Cameron and James, 1986), goods and services (Carson *et al.,* 1992), amenities (Imber *et al.,* 1993), outputs (Freeman, 1993) and asset (Shechter *et al.,* 1997 and Tyrväinen, 2001). The terms ‘goods’ or ‘goods and services’ are used interchangeably throughout this study to indicate such outputs.

revision of ADP funding is required for various reasons: (i) failure to mobilize internal resources, (ii) failure to mobilize external resources, (iii) external shocks (e.g. the war in the Middle East, Asian currency crisis and recession in Western economies), (iv) internal shocks (e.g. flood, cyclone and other natural disasters), (v) change of political regime, and (vi) change of priority (e.g. a shift from nationalization to privatization). Due to the non-availability of details about the projects/programmes and their components responsible for such a shortfall, this issue was raised with concerned officials at the Bangladesh Planning Commission during the fieldwork[17] for this study. It was revealed that at all levels of pruning – micro (at the agency level), meso (at the ministry level) and macro (at the Planning Commission level) – projects/programmes which generate 'intangible' benefits (e.g. environmental improvement) are usually subject to indiscriminate allocation cut. Even at the agency-level, while doing any internal adjustment, such activities are given lower priority in terms of resource allocation.

Although market forces are perceived as the ruling mechanism in the sense that they will ensure "getting the prices right", there are ample examples, particularly in the context of a developing country, where the market mechanism cannot ensure efficient allocation of scarce resources, specifically due to the publicness of some goods and services and externalities which lead to market and policy failure (this is discussed in greater detail in *Chapter Three*). Public intervention is necessary to provide these goods and services. Monetization of non-market benefits is not a decision criterion *per se*; rather assigning a monetary value will at least provide some information and will facilitate the decision-making process. As Pearce *et al*. (1994) state "… unless environmental resources are correctly priced – so as to be reflected in actual decisions – there will be distortions in the economy which will have the effect of biasing investment and policy decisions against environmental concerns" (p: 239).

1.3 Application of Non-market Valuation in Bangladesh

Various methods have been used in the past few decades for the valuation of non-market goods and services, such as public goods and environmental resources, both in developed and developing countries[18]. Non-market valuation has yet to gain any footing

[17] Detailed information about the fieldwork is described in *Chapter Four*.

[18] Details about various non-market valuation techniques are described in *Chapter Three*.

in Bangladesh. There have been a few preliminary valuation exercises in the country with regard to development projects, programmes or policies. Chowdhury (1999) used the contingent valuation method to estimate the willingness to pay (WTP) of poor urban households in two slum areas in Dhaka City for public water connection (common tap for shared use). Shammin (1999) applied the travel cost method to determine people's willingness to pay for the services of the Dhaka Zoological Garden. Haque *et al.* (1997) applied the hedonic price method to estimate the loss of human health and land values due to a deteriorating environment caused by pollution from the tanneries in Hazaribagh.

Of all these studies, only one (Chowdhury, 1999) has been conducted applying the contingent valuation method (CVM), although it focused only on the derivation of benefit estimates rather than on the basic issues of the implementability and validity of applying valuation methods in Bangladesh. None of the studies examined the applicability of this technique in a 'non-American' and 'non-European' cultural context. For example, no empirical comparison of different elicitation techniques in the case of the contingent valuation method, such as that by Boyle and Bishop (1988), was tried under local conditions. Only the individual elicitation technique was applied in the respective endeavour, e.g. bidding game approach in Chowdhury (1999).

Therefore, the absence of (i) application of economic analysis; (ii) application of non-monetization of environmental benefits; and (iii) an integration of monetization of non-market goods and services into economic analysis, leads to resource use conflicts and mis-allocation of resources. Two examples pertinently illustrate how mis-allocation of resources and the failure to appreciate non-market benefits lead to resource destruction in Bangladesh.

First, since the 1960s Bangladesh has followed a policy of self-sufficiency in food (in fact in cereal) production. The main strategy was to expand the irrigation network and cultivable land under crop production. To do so, many wetlands and floodplains were converted, mainly under the prescription of the World Bank[19], into rice fields ignoring the benefits of their value for maintaining ecological balance. Recently, the World Bank (1997) recognizes that "[t]he habitat of fish, a major source of protein for the rural poor, is under threat from the increasing conversion of land to agricultural use. Inland navigation is hindered by blockages in the river delta" (p: 3). The benefits of preserving floodplains and wetlands have not been weighed in the decision-making process against the benefits of conversion into agricultural uses which lead to massive destruction of unique natural resources in many parts of the country.

Second, over the last few years, particularly in Dhaka City, open spaces such as playgrounds, lakes and parks have been continuously converted into residential houses or commercial enterprises. Government agencies, even the custodians of the city – Dhaka City Corporation (DCC) and Rajdhani Unnayan Kartripakkya (Capital City Development Authority/RAJUK) – are in some cases responsible for such short-sighted decisions. Some recent reports which appeared in the national daily newspapers in Bangladesh are presented below.

> The Gulistan Park, one of the last remaining parklands in the Old City, is vanishing fast. The Dhaka City Corporation (DCC) has rented a stretch of the parkland for building of commercial shops… [the DCC] rented 840-square feet land… at Tk 3,360 (Tk 4 for each square foot) as monthly rent on a temporary basis for commercial use (*The Daily Star,* 7.3.02).
>
> Indiscriminate filling of Gulshan-Banani-Baridhara Lake, RAJUK's bid to build commercial structures on public parks and open spaces and unplanned commercialization of residential plots are fast changing Gulshan Residential Model Town into an urban ghetto. The ever-shrinking silhouette of the Gulshan-Banani-Baridhara Lake snaking through the posh residential areas tells a grim story of indiscriminate land filling, resulting in possible extinction of the waterbody… At the nearby Gulshan Avenue, a playground has disappeared… At Gulshan-2 roundabout, at least three public parks have disappeared or are in the process of disappearance (*The Daily Star*, 8.3.02).
>
> The Dhaka City Corporation (DCC) has 'secretly' revived a project to fill up a natural canal in the city's Mohammadpur area next to the martyred intellectuals' monument and build a truck terminal there. The Haikkar Khal winds its way from Turag in the northwest through Mohammadpur and joins the Buriganga River in the south. Over the years, Dhaka has already lost 22 natural canals due to similar 'mindless' decisions by the successive governments. …The Haikkar Khal is one of the last remaining and fast flowing canals in the city, which remains 'alive' even during lean periods (*The Daily Star*, 18.8.02).

These examples are not isolated cases. Over the years, major conflicts have arisen over the use of the country's scarce resources. Some of the most prominent disputes have centered on the use and management of water, forest, land and mineral resources. Disputes have focused on whether fragile natural resources should be allowed to be restored and preserved or be destroyed. These disputes show that non-market benefits have not been adequately accounted for in the decision-making process against their commercial values. As a whole, the protection and conservation of key natural systems

[19] In this process, a major part of the largest wetland in the northern part of the country, *Chalan Beel,* has been converted into agricultural farmland.

and important ecological functions are not considered in terms of their non-use values (e.g. these systems and functions may provide invaluable support and protection for economic activity and human welfare) in the decision-making calculus.

The problem regarding the lack of appreciation of non-market benefits is a general issue common to a wide range of countries, including developed ones. One such example might be the Ningaloo Reef of Western Australia[20]. More than 260 km in length, Ningaloo is the longest and most spectacular 'fringing' coral reef in Australia. In near pristine condition, it supports a staggering abundance of fish (500 species), corals (200 species), molluscs (600 species) and many other marine invertebrates. A large inland marine resort development at Maud's Landing on the boundary of the Ningaloo Marine Park has been proposed. In its first phase, it will cover 312 hectares, having an accommodation capacity in excess of 2500 people and 371 residential plots. This proposal has recently created a debate between the developers and a group of conservationists and environmental activists. The latter group claims that if the proposed mega-resort and marina are allowed to develop in the heart of a unique natural heritage, it would cause serious and irreparable damage to its rich and diverse ecosystem. This is an example where 'astonishing and unique' environmental values are not weighed against their commercial values[21]. Examples like these exist across the globe.

1.4 Research Agenda within the Domain of Current Debate

A wide body of literature, both theoretical and empirical, is currently available to estimate non-market benefits. The most widely used technique of economic valuation, the contingent valuation method, has been chosen to estimate non-market benefits in this study. The relevance of the CVM for this study is described in greater detail in *Chapter Three*. However, neither its theoretical underpinning nor its real-world application is beyond controversy. A host of theoretical and practical issues are at the forefront of debate, the most common being the question of *whether or not this technique is valid for the purpose to which it is being applied.* Professional opinion regarding the validity and reliability of the method remains divided (see, for example,

[20] Much of the information about Ningaloo Reef is adapted from the website (http://www.saveningalooreef.org, access on 12.6.2002) and leaflet provided by *The Save Ningaloo Campaign*.

[21] However, in July 2003, the Government of Western Australia has decided to stop the proposed development (*The West Australian*, 5.7.03).

Diamond and Hausman, 1994; Hanemann, 1994 and Portney, 1994). Many technical issues are still debatable, for instance, the issue of which elicitation mechanism is able to derive appropriate measures of non-market values has yet to be resolved. These are discussed in greater detail in *Chapter Three* and *Four,* while describing conceptual and theoretical issues of the study and designing the survey procedure respectively.

Another issue concerning the use of the valuation technique, particularly CVM, is its application in developing countries. In most cases, it has been transferred without taking into account the social, economic, political and cultural settings of developing countries. For instance, the same kind of elicitation method is applied, although many of the respondents are extremely poor and many of their economic activities are outside the purview of the monetary mechanism. Little attention has been paid to the applicability of valuation methods in different socio-economic and cultural contexts. Therefore, more research is required in relation to its application in developing countries.

Although some research has been done in the area of cleaning up polluted rivers, this is narrow in scope – narrow in the sense that the reasons which cause rivers to die are perceived only from a sectoral perspective (e.g. industrial pollution, dumping of waste, low flows and narrowing of channels). In many cases, the problems rivers face are multi-dimensional involving many stakeholders and sectors. This needs a holistic approach in the design of a cleanup programme. This study takes such an approach[22].

In Bangladesh, despite a few sporadic attempts to apply the valuation techniques in general and CVM in particular, no study exists that attempts to estimate non-market benefits of environmental improvement or change or to integrate these into the economic analysis. Neither have any studies been conducted on the issue of river cleanup in Bangladesh. Such aspects of valuation still remain largely un-researched both in Bangladesh and in general. However, due to the important role of rivers in Bangladesh[23], such research is urgently needed. Furthermore, because of the key role of public sector policy decision making in Bangladesh, an attempt to integrate environmental considerations into the policy decision making not only fills gaps in this process, but also contributes to further the methodological development of concepts and

[22] A very short description of the cleanup programme proposed in this study is provided later in this section, however, details are elaborated in *Chapter Three* and *Chapter Six*.

[23] Details of this role are elaborated in the next chapter.

theories of valuation techniques and cost-benefit analysis in the context of a developing country. Given this, the particular focus of this research is to develop a framework for estimating the benefits of non-marketed goods and services, and to integrate these values into the decision-making process.

Before going further, it would be advantageous to clarify that the deficiencies in the public sector decision making with regard to project analysis identified in the previous section apply to each sector of the economy in Bangladesh, particularly productive sectors such as water, gas, transport, agriculture, telecommunication, industry and energy. For the purpose of developing a framework of discussion, a case study on the water sector with reference to a particular river named Buriganga has been selected. This river is extremely polluted and near to biological death. A hypothetical cleanup programme has been designed in order to examine the applicability of the economic valuation technique and integrate the derived values into economic analysis. The reasons behind choosing the Buriganga River are described in the next chapter. As a passing comment, it can be mentioned that the case of cleanup of the Buriganga River represents the nature of a public good[24] and would also generate enormous non-market value which is the subject of this study.

The selection of the project is also justified on the grounds that the proposed cleanup is a big project involving heavy expenditure of public funds and represents one of the most important sectors of the economy. Most importantly, some of the outputs expected to be generated by the proposed programme are considered to be either non-marketed or without any market, and, thus, traditionally perceived to be difficult to 'measure for economic value'. Therefore, an analysis of such a programme could serve as a pointer to the general pattern of project economic analysis in the whole of the public sector of Bangladesh for which any economic analysis is considered to be 'difficult'. Furthermore, the methodological development which will take place during the research will be replicable across all sectors of the economy.

Therefore, it can be summarized that the existing knowledge and techniques of: (i) applicability of the valuation technique in developing countries; (ii) designing the cleanup programme for dying rivers; and (iii) integration of the environment into policy decision making, are not enough to solve the problems countries and particularly developing countries face in their resource management and efficient resource allocation. Hence, this study addresses the methodology in general. It develops and examines the applicability of an extension of the conventional valuation method in the case of Bangladesh for the particular case study described above. Nonetheless, the applicability of the findings of this study will go beyond the case study to other sectors and countries due to the resemblance of the research problems and the universality of the proposed approach.

1.5 The Research Questions

For the reasons described above, further research is warranted, and indeed urgently needed for improving the policy decision-making process in developing countries and Bangladesh in particular. The focus of this study is on examining the applicability of a non-market valuation method in the context of a developing country. An analysis in the context of a developing country is important on several accounts.

Although it originated and was initially applied in developed countries, the contingent valuation method has been used in developing countries as well. However, many assert that "CV [contingent valuation] surveys are not appropriate for use in developing countries because questions about nonuse values are not relevant to developing countries" (Russell, 2001: 333). The effort to apply the contingent valuation (CV) in developing countries is also criticized because "… environmental functions and components are much more important as inputs to production processes than as environmental amenities generating recreation or nonuse values" (*ibid*). The application of CV in developing countries presents a number of unique challenges. For one thing, many of the economic activities of the developing countries are only partially monetized, causing difficulties in translating respondents' preferences into monetary terms. Thus, some other unit of value needs to be considered which can be appreciated by the target population and also be familiar to them.

Furthermore, developing countries are different from developed countries in many ways. These include lower incomes, higher rates of unemployment, the existence of informal markets, differences in social values, less recreation time and a relatively greater role for resource extraction. These differences imply that there may be corresponding differences in the relative importance of specific sources of benefits and the way residents perceive the economic valuation of non-market resources.

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[24] The terms public good and environmental good are used interchangeably in this thesis as both are collectively provided and satisfy non-excludability and non-rivalry in consumption in the context of Bangladesh.

Therefore, it is particularly important for better and informed decision making:

- that the theoretical analysis is stepped up to examine the applicability of valuation techniques in developing countries' context;
- that the benefits of non-market goods and services need to be monetized; and
- that the environmental dimensions need to be incorporated into the policy decision-making process to reflect more fully the economic value of resources.

The central research question of this study is how to identify and estimate the economic values of non-market benefits of a project/programme so that they can be incorporated into the decision-making process. Thus, it will focus particularly upon four issues:

i) review and analysis of the body of knowledge both in the areas of cost-benefit analysis and non-market valuation in order to further methodological development;

ii) application of economic valuation techniques to illustrate how non-market benefits can be assigned monetary values in the case of a selected programme;

iii) recommendation of ways to incorporate these economic values of environmental benefits into the decision-making process and economic analysis in particular; and

iv) analysis of possible implications from (i) to (iii) for the selected environmental improvement programme.

1.6 The Research Objectives

The overall aim of this research is to further improve the methodology for integrating environmental concerns of development projects in general and valuation of non-marketed goods and services in particular. Specific attention has been given to the policy decision-making process. These methodological and policy issues have been examined through application to the case study of a dying river in Dhaka City, the capital of Bangladesh.

Therefore, the specific objectives of this study are as follows:

- to analyze existing theoretical frameworks and approaches to include environmental concerns into the decision-making process;

- to review and analyze the cost-benefit analysis and non-market valuation technique;
- to examine the applicability of the valuation technique in the case of developing countries;
- to develop a valuation approach and to apply it to estimate both non-market and total benefits of the environmental improvement of the selected case study;
- to estimate total costs of the cleanup programme of the Buriganga River;
- to analyze the water sector in Bangladesh with reference to vulnerability of rivers;
- to find ways for the policy intervention required at the local level to protect rivers; and
- to examine the suitability of integration of environmental considerations into the decision-making process with special reference to Bangladesh.

1.7 Scope of the Study

There are many tempting side issues that are of great importance but which, in order to achieve clarity and focus and keep within space/time constraints, need to be excluded from the scope of this study. The focus is on the benefit estimation of non-market goods and services and their integration in the decision-making process. Other issues receive attention only in as much as they are relevant to this issue.

This study uses various theories and concepts from economics, statistics, survey research and many areas of environment (e.g. solid waste and wastewater management, water resources and river management). This study does not try to examine the validity of these concepts and theories.

Several examples of important issues that are largely outside the scope of the thesis need to be mentioned. These include:

- There are aspects of non-market valuation other than the benefit estimation, e.g. internalization of costs, which is outside the purview of this study.
- The concept of project appraisal could be applied for both *ex ante* and *ex post* evaluation. In this study, an *ex ante* analysis has been examined.
- As far as the survey is concerned, the aim is to provide an economic valuation of non-market components of the cleanup programme. There is limited scope to test the survey results for some alternative procedures, e.g. alternative payment vehicles like municipality tax, or elicitation formats like bidding game or dichotomous

choice. Also, it is not known whether the CV survey is sensitive to higher education or income.

- Economic analysis is only one part of the overall analysis of the project or programme. It takes for granted that the project is technically sound and its institutional arrangements will be effective during the implementation, although many of the existing problems are due to lack of proper institutional arrangements, particularly in the Bangladesh context.
- Policy-making is not solely based on an efficiency criterion. Decision makers may have other objectives besides economic efficiency. For example, a policy-making body may be concerned with equity considerations, intergenerational effects, the sustainability of resource systems, social risk aversion or poverty alleviation. The argument is in line with Freeman's (1993) view that "it is not particularly useful to advocate CBA [cost-benefit analysis] as a simple decision rule. Rather it should be considered as a framework and a set of procedures to help organize available information. Viewed in this light, CBA does not dictate choices; nor does it replace the ultimate authority and responsibility of decision makers. It is simply a tool for organizing and expressing certain kinds of information on the range of alternative courses of action" (pp: 9-10).
- The purpose of putting a price tag on the environment is to incorporate it into the economic decision-making process. Another way that environmental values are incorporated into economic decision making is through using economic instruments, such as pollution charges, deposit-refund schemes, subsidies and removal of subsidies and tradeable emission rights. Economic instruments that aim to internalize environmental impacts into the decision-making process and therefore, create an incentive to curtail environmental damages or to adopt an environmental improvement mechanism, are outside the purview of this study. The study also considers institutional, legal, regulatory and non-regulatory issues of the cleanup of the Buriganga River on a very limited scale, as much as they are relevant to the issue of economic valuation.
- Other than the valuation of non-market goods and services and their integration into the decision-making process, this study does not take into account other ways of bringing environmental considerations into the process, such as incorporating risk, uncertainty and irreversibility issues.

- Although CBA is used in a wide range of public decision-making settings, the focus for this study is on its use in decisions concerning public sector investment.

1.8 Structure of the Thesis

Following the introduction, the thesis has six chapters.

Chapter Two discusses the problems and prospects of the water sector in Bangladesh. It provides a detailed description of the river system and the emerging threats rivers are facing in Bangladesh. The chapter also provides a detailed description of the Buriganga River, the case study on which the application of the valuation technique, examination of policy decision-making process and framing of a cleanup programme have been designed. In examining the level of water quality of the Buriganga River, the sources of pollution have also been identified.

Chapter Three deals with the conceptual and theoretical issues of the study. After providing an overview of the conceptual basis of value, the chapter presents the theory of benefit estimation. It describes various valuation techniques, and strengths and weaknesses of the contingent valuation method. The conventional contingent valuation technique is extended in that, in addition to asking respondents about their direct contribution of cash, the new approach also asks respondents about their contribution in terms of time. This is not another way of asking the valuation question, rather a new approach which is considered to be better in order to elicit respondents' preference for environmental improvement. The chapter then focuses extensively on the issue of integrating non-market values into the cost-benefit analysis. Previous empirical studies are also briefly reviewed. The contingent market is defined, and resources needed to be valued through extended contingent valuation (ECV) survey are identified.

Chapter Four is concerned with the description of the methodology and the designing of survey procedures to be used to estimate the non-market benefits of the cleanup programme outlined in the previous chapter. A variety of data (e.g. both market and non-market) is compiled from both primary and secondary sources using a number of methods. These methods are described in this chapter with a detailed focus on the survey design procedure adopted for this study. Also, sources of potential bias associated with the contingent valuation survey are described along with the measures adopted to avoid them.

Chapter Five estimates the non-market benefits of the Buriganga River cleanup programme (BRCP) using the ECV survey. A willingness to contribute value for the participants of the CV survey is derived and inferred for the residents of Dhaka City. This value constitutes the core of the total economic value which is used, along with the market benefits, in the next chapter in order to conduct an extended cost-benefit analysis for the BRCP. The survey also provides respondents' priorities, perceptions, preferences and opinions in regard to the Buriganga River which might be useful in targeting public awareness programmes and in shaping policies.

Chapter Six estimates the total benefits and the total costs of the BRCP and thus examines the suitability of integration of environmental considerations into the decision-making process. The integration takes place in the form of examining the economic viability of the BRCP, applying the techniques of extended cost-benefit analysis. It is essentially an extension of the conventional CBA through integrating environmental dimensions. The main purpose of the economic analysis is to examine the viability of the BRCP from the perspective of the society as a whole.

Finally, *Chapter Seven* provides a summary of the major findings from the research, conclusions and suggested recommendations.

Alam, Khorshed. (2003). *Cleanup of the Buriganga River : integrating the environment into decision making*. PhD Dissertation. Perth, Murdoch University.

Chapter Two
THE BANGLADESH WATER SECTOR IN PERSPECTIVE

2.0 Introduction

Bangladesh is constituted by a large delta at the confluence of three major world rivers, the Ganges, the Brahmaputra, and the Meghna. These three rivers originate outside Bangladesh and flow through China, Nepal and India before they enter Bangladesh and finally drain out into the Bay of Bengal. The physical setting of Bangladesh along with its monsoon climate means there is limited control and management of the inflow of water into the country. Although Bangladesh is predominantly a plain surface, it is criss-crossed by a very high density river system. This gives the country a riverine nature which is present in the life style, customs, economy and history of its people. All of these issues are fundamental to any discussion of the water sector, planning and policy decision making in Bangladesh. Proper maintenance of rivers is very important not just because of their crucial role in maintaining ecological balance, but because the very existence and future development of this 'new' delta are dependent on the river system.

The aim of this chapter is to present an overview of the water sector, river system and the role rivers play in socio-economic life in Bangladesh. It also provides a description of the Buriganga River, the main river around which the capital of Bangladesh, Dhaka, was established, and the rationale for choosing it as a case study for this research. The remainder of this chapter is structured as follows: Section 2.1 describes water resources, both ground and surface water, in Bangladesh, which is followed by a discussion of the river system and the emerging threats to the rivers in Bangladesh. Next, patterns of water sector investment in Bangladesh and water sector policy and planning issues with respect to rivers are analyzed. Section 2.2 provides the rationale for choosing the Buriganga River as a case study. It starts with a description of the Buriganga River system and provides the magnitude of water quality importance. This is followed by an analysis of the uses of the Buriganga River water. It also describes sources of pollution – from both point and non-point sources. Finally, some conclusions are drawn in Section 2.3.

2.1 Water Sector in Bangladesh

The Bangladesh water sector consists of both surface and ground water, which are discussed below. The importance of rivers in the socio-economic and cultural life of Bangladesh people and the threats rivers are facing are also described in this section. The purpose is to illustrate the broad picture of the water sector both from the perspectives of problems and potentials.

2.1.1 Water Resources

Water resources, consisting of surface water from rivers, canals and ponds as well as ground water at different layers, play a vital role in agricultural, forestry, fisheries and livestock production and municipal and industrial uses in Bangladesh. They also play significant roles in settlement patterns, domestic water supply and communications and, indirectly, in sanitation and health. The environment, economic growth and development of Bangladesh are highly influenced by water – its regional and seasonal availability, and the quality of surface and ground water. The spatial and seasonal availability of surface and ground water is highly dependent on the monsoon climate and physiography of the country. Both surface and ground water in terms of their use, overuse, quality and supply remain issues of concern, and are discussed in part later in this chapter. A brief description of the surface and ground water system in Bangladesh is provided below.

Ground water is an important resource in Bangladesh and extensively used for domestic, agricultural and industrial purposes. There is a fairly large aquifer at a very shallow depth of 6-12 metres below ground level. A deeper aquifer at about 87-175 metres depth has also been identified in many parts of the country and has been used for irrigation purposes. Recharge to ground water occurs primarily through direct infiltration from rainfall. The ground water reservoir is hydraulically connected to the major streams of Bangladesh. At high stages in the rivers, in monsoon, there is a direct recharge into the upper aquifer after rainfall. At lower stages of the rivers, the discharge is from the aquifer to the river. Upstream diversion of surface water from major rivers affects ground water levels in the country and increases salinity in the shallow aquifer of the coastal region.

The **surface water** system of the country consists of numerous rivers, canals, ponds and other water bodies. Bangladesh has about 24,000 kilometres (15,000 miles) of rivers, streams and canals that together cover nearly 7 percent of the country's surface. Some of the biggest rivers in the world flow through the country and form the largest delta in the world. The Ganges-Brahmaputra-Meghna river system in the Bengal Basin (popularly known as Ganges-Brahmaputra-Meghna Basin or GBM Basin) dominates the surface water system of the country (see Map 2.1). The total catchment area of these three river basins is about 1.72 million square kilometre (sq km) of which less than 7.5 percent is within Bangladesh. Bangladesh receives 101 million hectare-metre of surface water annually from catchment area outside its borders and 12 million hectare-metres from within, giving total availability of 113 million hectare-metres of surface water annually (MOWR, 1998). The country has the highest per capita availability of surface water in the world.

2.1.2 The River System

The river system is one of the most influential natural phenomena of Bangladesh's culture, economy and politics. The country has the world's highest density of rivers per unit of area, so it is commonly referred to as "the gift of the rivers" (Ahmed, 1998: 3). As can be seen from Map 2.2, almost all rivers belong to the three river systems: the Ganges (called the Padma in Bangladesh); the Brahmaputra (called the Jamuna) and the Meghna.

These rivers meet in Bangladesh and form the world's largest delta. At 60,000 sq km (23,000 sq miles), this delta is twice the size of that formed by the Mississippi and three times the area of the Nile delta. These three rivers also give Bangladesh "one of the world's most complex river systems" (Jansen *et al.*, 1989: 40). Two hundred and thirty rivers including tributaries and distributaries criss-cross the country, many of which are small and insignificant in terms of flow volumes. Fifty-seven of the rivers of Bangladesh are transboundary rivers, of which fifty-four including the Ganges, Brahmaputra and Meghna come from India and three come from Myanmar. About 93 percent of the

Map 2.1

Map 2.2

catchment of these rivers is located outside the country and only about 7.5 percent of the drainage area is within Bangladesh. This has left the country with very little control over the inflow of water and sediment load that moves over its surface and discharges into the ocean (Bay of Bengal). The combined drainage area of the three major rivers is over 2.1 million sq km (800,000 sq miles). It covers parts of India, Bhutan, Nepal and China. The combined outflow of these three rivers is only exceeded by the Congo and the Amazon and is greater than the combined flows of the 20 largest rivers in Europe (Jansen *et al.*, 1989). Bangladesh is thus the meeting place for the region's rivers. This river system discharges about 142 thousand cubic metres per second into the Bay of Bengal at peak periods (Rahman *et al.,* 1990).

The rivers and streams in the north are mostly tributaries and in the south-west are mostly distributaries of the Ganges. The density of rivers is also higher in the south. In most cases, except for the few major rivers, proper navigation is limited only to the rainy season, i.e. for about 3 to 4 months (July to October) mainly due to the non-availability of water in the rivers in other seasons. Except for the hilly regions in the north-east and south-east part, the whole country consists of low and flat land formed mainly by the Ganges and the Brahmaputra River systems.

More than 80 percent of the total annual rainfall over the country occurs during the monsoon (June-September) and the average annual rainfall is 2320 millimetres (mm). The flows in the rivers of Bangladesh are highly seasonal. The country faces two major hazards: floods during the monsoon (June-September) and scarcity of water during the dry season (November-May).

2.1.3 Importance of the Rivers

Rivers are the glory of Bangladesh and transcend all aspects of life. The thousands of miles of rivers and canals are the lifeblood of Bangladesh and its people. The whole country is laced and criss-crossed by rivers – both big and small (see Map 2.2). They have traditionally been the main arteries along which passengers and all types of cargoes have been transported. The waterways are integrated into the whole economy at all levels. They carry exportables-importables to and from the nation's ports or factories. They also transport local products and produce over short distances to the thousands of *hats* and *bazaars* (both small and big market-places) located along them. The towns and villages of Bangladesh have grown up along its rivers and canals. In fact, almost all of the old administrative districts in Bangladesh were established and have grown on the bank of one or more rivers. Industries are also traditionally located on the bank of rivers and streams, for the purpose of easy transportation and waste disposal.

Inland waterways are the most important mode of transport for maintaining communication networks in the remote areas of Bangladesh. However, waterways in Bangladesh have been shrinking in length and width. About 7,715 km of river routes across the country have become unfit for navigation due to siltation and other reasons in the past thirty years, while another 3,300 km routes have become risky for operation of riverine vessels[1]. The total length of the river route was 13,175 km in 1975, but it reduced to 8,400 km during the rainy season and 5,200 km during the dry season in 1984. The route has now declined to 6,000 km in the rainy season and 3,800 km in the dry season.

Bangladesh has an estimated total of 24,000 km of drainage channels, although their water conveyance and navigability have been seriously threatened by continuous morphological change of the river-beds (PC, 1998). The net cultivable area in Bangladesh is 8.77 million hectares (ha) of which 7.55 million ha are potentially suitable for irrigation. By 1999, about 4.35 million ha had been brought under irrigation. Of the total irrigation coverage, surface water irrigation covers 1.2 million ha of which major irrigation (i.e. FCDI) projects cover 0.36 million ha or 8.28 percent (PC, 2000). Major FCDI projects are the Chandpur Flood Control and Irrigation Project, Dhaka-Narayanganj-Demra (DND) Project, Ganges-Kabadakhya Project, Pabna Irrigation Project, Teesta Barrage, Meghna-Dhonagoda Project, Narayanganj-Norshingdi Flood Control and Drainage Project. All these projects are based on major rivers of the country.

The water flow of rivers has also reduced over the years due to increasing withdrawal of water and construction of many dams and irrigation structures in the upper catchment areas[2] and also construction of human-made structures, such as embankments and roads inside Bangladesh. In addition, the level and extent of pollution

[1] Personal communication with the Bangladesh Inland Water Transport Authority (BIWTA) officials.

[2] India has so far constructed 3,600 dams in the upper catchments of Bangladesh rivers (Roy, 1999). In addition, India has recently designed a plan to withdraw substantial quantity of water from major rivers including the international rivers – the Ganges and Brahamaputra that flow through Bangladesh and, thus, divert flows to southern parts of the country (Rashid, 2003).

has increased in the waterways, particularly in rivers passing through major cities and towns[3]. Notwithstanding these changes, the river system still has a significant role in the country's economy. Bangladesh depends on its river system for such purposes as agriculture, navigation, sanitation, drainage, forestry, fishery and control of salinity. The ecosystem of the country is highly dependent on the river system and any upset in the supply of water in the system is sure to bring about changes in the living systems including people, flora and fauna. Rivers in Bangladesh provide a significant source of water and will continue to play this role in the future for irrigation, fisheries, navigation, recreation, and domestic and industrial purposes among others. Surface water is also important for drinking and other purposes due to the incidence of arsenic contamination of groundwater in most parts of the country[4].

2.1.4 Threats to Rivers: Some Issues

Rivers in Bangladesh have been threatened from time immemorial. Indeed, threats date back to the early history of civilization and development. Being a new delta, the courses of rivers are constantly changing[5]. The problems related to rivers in Bangladesh can be categorized as natural, climate change-related, external to the country and human-made. A content analysis of emerging threats to rivers in different parts of Bangladesh, as described in the national newspapers, provides a picture of some of the problems rivers are now facing[6]. In recent years, water quality related issues have surfaced along with water quantity (flow) concerns. A summary of all these problems is presented below.

Natural Problems

- *River-bank Erosion:* The floodplains and coastal delta are in a constant state of slow morphological change. The large seasonal variation in river flow results in a varying sediment transportation capacity and causes river-bank erosion, migration of river-banks and meandering river channels. Satellite image studies of the Ganges-Brahmaputra-Middle Meghna rivers show that 106,300 ha were lost to erosion, while only 19,000 ha were accreted over the period 1982-92. The net area of 87,000

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[3] This is discussed in greater details later in this chapter.

[4] The extent of *arsenicosis* is discussed in greater detail later in this section.

[5] Only 200 years ago, the Old Brahmaputra was the main channel of the Brahmaputra-Jamuna River which is now a narrow channel. Because of some geological events, possibly an earth quake which caused faulting and tilting of the adjacent pleicestocene sediments, the river shifted its course to the present one (Abbas AT, 1974).

[6] The method of content analysis is described in *Chapter Four*.

ha lost to erosion is equivalent to an annual erosion rate of 8,700 ha (PC, 1998). Most of it is agricultural land. River-bank erosion has significant socio-economic impacts; the loss of land, crops, property and livelihood has led to landlessness and impoverishment of thousands of households. Structural measures like river-bank protection and canalization for mitigation of erosion in the extremely dynamic river valleys of Brahmaputra, Ganges, or lower Meghna appeared to be ineffective.

- *Gradual Siltation in Riverbed and Floodplain:* The three major rivers, along with innumerable tributaries and distributaries used to carry about 2 to 2.4 billion tons of sediment[7] every year into the country (Jansen *et al.*, 1989). Only about 5 percent of the sediments are deposited in the riverbed and floodplain, and the rest is discharged into the Bay of Bengal. Besides the regional geography, overuse and destruction of forestland and other natural resources by humans in areas up and downstream of the rivers have led to an increased sediment load in the river system. Part of the load is deposited on the floodplain, gradually changing its topography and seriously reducing the carrying capacity and navigability of drainage channels. The sediments carried by the rivers are likely to cause more problems in the face of a possible sea level rise resulting in more water logging and loss of agricultural lands and blocking of drainage channels.

- *Low Water Flow:* Over the last few decades, water levels in the major rivers in the dry season have shown a declining trend. As a result, there is practically no water flow in small tributaries and distributaries that play an important role for biodiversity as well as agriculture and fisheries. The lean flow of the major rivers also plays a critical role in saline water intrusion into the river system, navigation problems in the rivers and puts pressure on groundwater for irrigation. One of the major impacts from the lowering of the river water flow in the dry season is the increasing surface salinity in coastal areas and salt-water intrusion.

- *Arsenic Contamination:* About 95 percent of the drinking water in Bangladesh is derived from groundwater, mainly through hand tubewells. The ground water is contaminated by naturally occurring arsenic in 59 out of the country's 64 districts and an estimated 24 million out of the country's 127 million people are affected (*The Daily Star*, 5.3.02). First detected in 1993, arsenic contamination far in excess of the World Health Organization's drinking water guideline value of 0.01 mg/l has

[7] The recent estimate is somewhat between 1.2 to 2.0 billion tons (DOE, 2001).

become a major health hazard in Bangladesh. To simply abandon arsenic contaminated tubewells and revert to untreated surface water sources would certainly reduce *arsenicosis*, but at the cost of an increased number of waterborne diseases. This also illustrates an immediate need for the development of safe and reliable surface water sources including river water.

Climate Change-related Problems

- *Rainfall Pattern:* In recent years, the meterological pattern has been erratic, with a reduction in the length of cool and dry season. Many believe that this may be the beginning of the long-term changes attributed to global warming caused by greenhouse gases (Alam *et al*., 1999). Although total rainfall has shown an increase, rainfall is scanty, irregular and erratic in the dry season (i.e. between November and May). There is hardly any rainfall, except for the pre-monsoon months of April and May. Only 22 percent of the total annual rainfall occurs over this seven month period, and the evapotranspiration is four times higher than the rainfall (DOE, 2001). As a result, drainage congestion and flooding are expected to intensify with time in terms of area affected, duration and depth (Alam *et al*., 1999).

- *Sea Level Rise:* A similar set of scenarios is expected in relation to sea level rise. According to the Intergovernmental Panel on Climate Change, half a metre rise in the sea-level will inundate 11 percent of the country's territory including the Sunderbans, the world's largest mangrove forest in Bangladesh (*The Daily Star*, 20.9.02). The impacts are expected to be in the form of drainage congestion, reduced fresh water availability, disturbance of morphological processes and increased intensity of disasters (e.g. floods, cyclones, drought and heavy monsoon rainfall).

Problems External to Bangladesh

- *Upstream Withdrawal and Diversion of* [illegible] 36 As a lower riparian country, Bangladesh has 57 transboundary rivers shar[illegible] India and Myanmar. The upper riparian countries have adopted innumerable development schemes in the upstream regions of these rivers. A significant amount of dry season stream flow is withdrawn, retained or diverted upstream. This has resulted in major adverse impacts on the environment and socio-economic conditions (e.g. salinity intrusion, drought, deforestation, loss of navigability and river traffic) in many parts of Bangladesh. The drastic fall in water flows is hampering irrigation in lands along the river sources. Salinity intrusion in the south-west has increased due to the low fresh water flow through the Gorai River (which runs from the Ganges) during the dry season. A number of water development projects along the upstream of the Ganges extracts water during the dry season which drastically reduces the flow of the Ganges in Bangladesh. Salinity intrusion in other rivers is due to reduced and reducing river flows which are the result of the construction of polders and embankments and increased and uncontrolled upstream extraction from rivers beyond the borders of the country. Bangladesh, being at the lower end of the three mighty rivers, has to face the consequences of environmental degradation (e.g. deforestation in the Himalayas) of upper catchment areas. As a whole, due to a fall in water flows, rivers have dried up and many shoals are emerging which threaten the rivers with death. As a consequence of upstream withdrawal and flow diversion, the viability of many irrigation projects in Bangladesh, notably the million-dollar Teesta Barrage Project, the largest irrigation project in the country, has been threatened. Also, the Ganges-Kobadak Project (popularly known as GK Project) has to be temporarily closed every year for few months.

Human-made Problems

- *Industrial Effluents:* Traditionally, industries are located on the bank of rivers. Due to lack of control of industrial effluents discharge, most industries find rivers an easy way to drain effluents (both solid waste and waste waters) without any consideration of environmental degradation. The most problematic industries for river health are tanneries, textiles, pulp and paper mills, weaving factories, fertilizer factories, industrial chemical production and refineries. A complex mixture of hazardous chemicals and toxic industrial [illegible]oth organic and inorganic, is discharged into the rivers from all these indu[illegible]ally without treatment. People suffer from health hazards due to the disposal of chemical and toxic wastes by mills and factories in many rivers of the country.

- *Municipal Wastes:* Most of the cities were developed on the bank of one or more rivers, and municipal wastes are usually dumped into the water. Sewer lines in many towns end up in the river, causing its slow death. The drains carry garbage including polythene bags. Dumping of garbage along the bank is practiced in the major cities of the country apparently to 'reclaim land' from the river.

- *Encroachment:* Due to the establishment of major cities along the rivers, many rivers are threatened by continuous encroachment. Unscrupulous people grab land on the foreshore or on the main channel and fill it with earth and other materials mainly because of the scarcity of land and lack of stringent rules and their enforcement. These illegal structures hinder the natural flow of the river, severely affect navigability, risk the rivers' very existence and pose a serious threat to ecological balance.
- *Oil and Lube Spillage:* There are innumerable mechanized trawlers and boats plying the waterways. Due to a lack of stringent regulation and their enforcement, combined with ignorance about their adverse effect on the environment, the operators of the vessels dump wastes, including burnt oil, into the water.

Among the many threats rivers are facing in Bangladesh, the last category is more or less avoidable and possible to keep under control. Nevertheless, the human-made problems are the ones which cause the most immediate damage to the rivers. Efforts have been made to deal with the problems, which are discussed in the section to follow.

2.1.5 Pattern of Water Sector Investment

In Bangladesh, water sector development planning in a systematic way dates back to the early 1960s. Implementation of water sector projects started in 1964 through the Water Sector Master Plan in the areas of flood control, drainage and irrigation including construction of barrages on major rivers. The main focus was to increase crop production (mainly rice). This did not take into account the potential impact on fisheries, navigation, forests, domestic and industrial water supply, bio-diversity and salinity management. A later review of the Master Plan in 1972 by the International Bank for Reconstruction and Development shifted the priority from large-scale projects to small-scale irrigation projects. The expansion of small-scale irrigation projects mainly concentrated on the exploitation of groundwater and this resulted in lowering the groundwater table and adverse environmental impacts in many parts of the country (Ahmad *et al.*, 2001). Prioritizing groundwater extraction and ignoring environmental impacts have created many problems, notably *arsenicosis* in many parts of the country.

There was a gradual shift in government policy from the early 1990s towards a more comprehensive and holistic approach in water management from expensive structural measures of flood control and drainage (*ibid*). The FAP studies, undertaken on the event of massive floods in 1987 and 1988, recognized the limitations of earlier plans which had focused too heavily on agricultural development without adequate consideration of the needs of other sectors. Past investment through development projects was justified mostly in terms of increased cereal crop production, which overlooked and, in some cases, exacerbated the water needs of sectors such as fisheries, forestry, domestic and industrial water supply, navigation, and the environment (WB, 1998). From the beginning, the FAP came under fire from development experts and environmental activists, and even from within the aid establishment (Yakub, 1994). The FAP studies were criticized for their perception of the Bangladesh water problem as merely "engineering", such as the "compartmentalization" or "controlled flooding model" which allows "some flood water onto fields regulating its flow with sluice gates built into the embankments" (*ibid*, p: 10). There are considerable controversies about the appropriateness of the compartmentalization model, particularly on the event of numerous evidence of embankment failures in Bangladesh (e.g. Beel Dakatia and DND irrigation project). The FAP is also criticized for the inadequate participation of affected people both in the feasibility and implementation phases and its top-down approach.

Many projects have been implemented in Bangladesh both at the local and national scale to mitigate river-bank erosion, maintain flow of water in rivers and excavation of riverbeds. All investments are directed towards maintaining water flow in the rivers. This means the focus of all development activities is on quantity issues. As a whole, development programmes put emphasis on ensuring sufficient flow of water and its use for various purposes. However, water quality issues are largely neglected. In addition, the river as an integrated development issue is not considered. Until 2000, there was no investment in water quality improvement. A very small amount of allocation was committed for two projects in the 2000/01 ADP. The overall approach is piecemeal and the improvement of water quality has been perceived as an isolated issue ignoring its inherent complexity and inter-sectoral dimensions.

Many organizations are involved with the design and implementation of policy planning, projects and programmes in the water sector. These are presented in Table 2.1 along with their charter of duties.

There are seven ministries and fourteen agencies involved with the planning and implementation of water sector policy and projects in Bangladesh (Table 2.1). Some agencies are as a whole responsible for water related activities (e.g. BWDB, DWASA, EGIS, RRI, SWMC and WARPO) and others are partly responsible (e.g. BIWTA, DA, DOE, LGED and RAJUK). Involvement of fourteen agencies often makes things complicated. The lack of coordination among agencies is a continuing issue of debate and it also creates a situation of duplication and overlapping of activities. For instance, BWDB, DOE and DWASA are all collecting water quality data in Dhaka City, but there are substantial differences among them in terms of water quality indicator values.

It is also hard to understand the overall public investment in the water sector because of the involvement of various agencies with varying levels of responsibility. Although both the ADP and Five Year Plan envisage an outlay in the water sector, it is mainly channeled through the Ministry of Water Resources and implemented by its agencies such as BWDB, WARPO, EGIS, RRI and SWMC. In addition to this Ministry and its various agencies, many ministries as well as agencies are at least partially involved with water-related projects and programmes (see Table 2.1). For instance, the Ministry of Local Government, Rural Development and Cooperatives spends money on water supply and sanitation. The Ministry of Environment and Forest through the

Table 2.1: *Organizations involved with water sector activities in Bangladesh*

Ministry/agency	**Responsibilities**
Ministry of Water Resources (MOWR):	
Bangladesh Water Development Board (BWDB)	Major surface water and other FCDI projects with command area above 1000 hectares, flood control, drainage, irrigation, erosion control, town protection, river training, watershed management and water quality monitoring
Water Resource Planning Organization (WARPO)	Water sector macro planning and policy formulation, and intersectoral co-ordination
Environment and Geographic Information Service (EGIS)	Collecting hydrologic, topographic, soil and flood regime data
River Research Institute (RRI)	Surface water modelling and river training studies
Surface Water Modelling Centre (SWMC)	Mathematical modelling of hydrological data
Ministry of Environment and Forest (MOEF):	
Department of Environment (DOE)	Overall environmental policy, setting and enforcement of environmental regulations and standards including the pollution control and monitoring of water resources
Ministry of Local Government Rural Development and Cooperatives (MLGRDC):	
Local Government Engineering Department (LGED)	FCDI projects with command area of 1000 hectares or less, river-bank protection, canal digging, drainage, embankment, land use planning
Department of Public Health Engineering (DPHE)	Planning and development of water supply in municipalities
Water and Sewerage Authority (WASA)	Water supply, drainage and sewage collection and water

City Corporations	quality monitoring in Dhaka and Chittagonj Drainage, sanitation, storm water management and solid waste management
Ministry of Works (MOW): Rajdhani Unnayan Kartripakkya (RAJUK)	Urban planning and management, land use planning and building regulation
Ministry of Land (MOL): District Land Administration	Maintaining land record and survey, leasing open and closed water fisheries and collection of rents and other charges
Ministry of Shipping (MOS): Bangladesh Inland Transport Authority (BIWTA)	Maintaining water channels and dredging of waterways for navigation
Ministry of Establishment (MOE): District Administration (DA)	Overall co-ordination including embankment construction

Source: Own compilation from various Acts.

Department of Environment has recently undertaken a study project on water quality monitoring. An attempt to estimate the total amount of allocation for the water sector in Bangladesh failed mainly due to the non-availability of such integrated data.

The ADP allocation in 2000/01 for water resource projects was Tk 9976.60 million which is 5.70 percent of the total ADP allocation. Project activities include surface and ground water irrigation, embankment and re-excavation, river-bank protection, controlled flooding, flood control, drainage and irrigation, construction of rubber dam, land reclamation in coastal areas, increasing conveyance capacity of rivers by de-siltation, *char* (shoal or sandbars) development, surveys, studies and investigations, operation and maintenance. Not only are investments patchy and insufficient, none is for water quality improvement or for programmes like the cleanup of rivers and pollution abatement.

2.1.6 Water Sector Policy and Planning

The major water issues are cross-sectoral, affecting almost all development sectors. The water sector, particularly river water, related policies and planning options are reviewed in this section. Policies relating to river water pollution, prevention and management are discussed along with institutional structures and legal aspects.

The Government of Bangladesh has promulgated many policies, plans and programmes in the natural resources sectors such as agriculture, water, fisheries, forestry, energy, public health and infrastructure. The water quality issues of the country (along with other environmental issues) were emphasized in the National

Environment Policy 1992, Bangladesh Environmental Conservation Act 1995, Bangladesh Environmental Conservation Rules 1997 and National Water Policy 1999.

The Bangladesh Environmental Policy 1992 is a general policy commitment to sustainable development with due consideration of the environment and conservation of natural resources. It also provides sector-wise (i.e. for 15 sectors) policy guidelines to develop sector-specific policies for the respective ministries.

The Bangladesh Environmental Conservation Act (ECA) 1995 was passed by the Parliament to provide for the conservation and improvement of environmental standards and to control and mitigate the pollution of the environment. Pursuant to the Article 20 of the ECA, the Bangladesh Environmental Conservation Rules (ECR) 1997 were formulated. The ECR set some criteria for ecologically critical areas of Bangladesh and procedures for environmental clearance for industry as well as development projects. They also set standards for air, water, noise, odour and other environmental parameters along with sewage effluent disposal and g 42 nission. For instance, inland surface water quality standards have been set for drinking, recreation, agriculture, industry and irrigation purposes.

The National Water Policy (NWP) 1999 also emphasized water pollution from the point of view of supply and demand side management issues. The NWP provides direction to all agencies and institutions working with the water sector for addressing the objectives of improved water resources management and protection of the environment.

For dealing with environmental offences, the Government has also passed the Environmental Court Act 2000. It provides for the establishment of six Environmental Courts in the country for speedy disposal of cases concerning environmental offences. However, the jurisdiction of the Environmental Court is yet to be specified and the Court is yet to start functioning.

Although there are several laws and policies in place in Bangladesh, there are very few intersectoral linkages and the implementation of these stated, often lofty, objectives is even worse. Despite ambient air and water quality standards being set and the establishment of an Environmental Court, the unabated pollution and encroachment of peripheral rivers surrounding Dhaka City continue to rise. It has also been alleged that the environment regulatory authority not only lacks capacity, leadership, commitment and continuity but can also often be an additional mechanism for rent seeking[8].

The regulations regarding control of pollution are essentially ‘end-of-pipe’ standards, or just abstractions. In other words, these are ‘command and control’ measures; economic incentive or market-based environmental policy instruments such as tradable permits, pollution charges, and deposit-refund systems for industries have not been considered for environmental quality improvement. Although there is an Ambient Water Standard (a total of 55 parameters of which some major ones are discussed later in this chapter), it covers none of the many chemical pollutions known to be discharged in the river waters (e.g. total alkalinity and electrical conductivity). There is no effective regulation that takes into account the ability of rivers to dilute and disperse effluent, especially in times of low flow and under complex cumulative discharge patterns. These cumulative impacts are crucially important for the natural aquatic environment (DOE, 2001).

Presently there are no strict rules and regulations to limit the discharge of any pollutant into the rivers. Industrial wastes as well as municipal sewer outfalls are discharging into rivers without any treatment. Due to the lack of strict legislation prohibiting direct discharge of sewage and waste, polluters do not treat their waste before discharging it into rivers.

Non-enforceability is another handicapping feature of the environmental law regime in Bangladesh. Enforcement of existing laws suffers from weak institutional capabilities, lack of knowledge about the law at the operational level, conflicts with traditional rights and practices, absence of resource survey and record, inadequate resource allocations and judicial procedures. For example, the Environment Court is yet to become functional although the Parliament passed the necessary legislation to set up the court at all the divisional headquarters in early 2000. The existing policies, rules and regulations are inadequate to deal with the current and emerging problems of rivers. Therefore, there is need for research to help alleviate this situation.

2.2 Case Study: The Buriganga River

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[8] There is an allegation that making the EIA mandatory for certain industries and projects under the ECR 1997, has created a source of additional corruption of the DOE officials who are allegedly involved with private firms in conducting an EIA (personal communication with one brick kiln owner in the study area on 20.6.01).

This research uses one specific case study in order to examine the applicability of a new approach of economic valuation and its integration into the decision-making process[9]. The Buriganga River has been selected as a case study for this research considering its enormous importance to the residents of Dhaka City. It also demonstrates the lack of a mechanism to incorporate the environment into decision-making which has resulted in significant environmental deterioration of the river.

The old Dhaka, now the Capital of Bangladesh, was established as a provincial capital of the Mughal ruler on the north-eastern bank of the Buriganga River during 1608-10, although the settlement is known to have been in existence since the 7th century as a small riverside township (Karim, 1991) (see Map 2.3). The Buriganga River attracted the Mughal rulers by offering good transportation and defense against enemies. Since then, Dhaka City has grown mainly on the northern and eastern banks of the Buriganga River until the 1960s, particularly because of the easy riverine communication almost throughout the entire country[10].

Dhaka City is now very densely populated and one of the ten ‘Mega cities’ of the world. The population has grown very rapidly, giving rise to unplanned residential development and scattered slum areas. Between 1947 and 1971, the city grew from an area of 1,800 ha to 18,000 ha and, by 1991, the city boundary embraced an area of almost 26,500 ha (160 sq km). Dhaka’s population has grown from 4 million in 1980 to 6.5 million in 1990 and an estimated 10 million in 2001 (PC, 1998 and BBS, 2001). Most of this increase in population is caused by the in-migration of people from rural to urban areas. The current area of the Dhaka City Corporation is 360 sq km with a population of 5.38 million[11].

The tremendous increase of population over the last three decades poses enormous environmental problems, including, among others, disposal of solid waste, sewage and drainage in Dhaka City. Furthermore, there are several industrial locations within the city which pose challenges for the environmentally sound management of industrial discharges. There are serious environmental problems in terms of water quality, particularly for the Buriganga River, arising out of the dumping of municipal

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[9] Details about this approach are described in *Chapter Three*.

[10] Since the1960s, Dhaka City started to grow north up to Mirpur.

[11] In fact there is no uniform boundary for Dhaka City. The Dhaka metropolitian area defined by the RAJUK is 1508 sq km which includes Savar, Tongi, Gazipur, Narayanganj and Keranigang. The Dhaka Water and Sewerage Authority (DWASA) area is 380 sq km. The Dhaka Statistical Metropolitan Area (SMA) covers 1353 sq km with more

waste and toxic industrial discharges from industries to its banks, especially from the tanneries of the Hazaribagh. The problem is compounded by the development of residential areas along the river-bank, increasing encroachment upon the land due to accretion on the river-banks, depletion of fish resources and loss of aquatic life. The

than 10 million people.

Map 2.3

Buriganga River thus presents a huge environmental management problem, having environmental, economic, social, cultural and institutional dimensions. There are a large number of stakeholders, such as development agencies, industrial and business communities and a huge population on either side of the river, all of whom depend on the river for their livelihood.

Besides the co-ordination problem among the agencies concerned with the water sector in Bangladesh discussed earlier, there is also the issue of river ownership which can be illustrated in the case of the Buriganga River. A pertinent question is who owns the Buriganga. According to the Port Act of 1908, the Government declared 17 km on both sides of the river from Kholamura to Fatulla as 'river port' and handed it over to the BIWTA in 1961. This demarcation has also been incorporated into the Port Rules 1996. Since 1962, the BIWTA has been paying land revenue to the Government. On the other hand, according to the President's Ordinance 135 in 1972, Land Administration under the District Office is responsible for the maintenance of off-shore river land as *khas* (government-owned but unallocated) land. Accordingly, the Land Administration of Dhaka District has 'leased or sold out' big stretches of foreshore areas to private persons. This has created complex legal problems, particularly when the BIWTA tries to evict these encroachers from the off-shore and shore of the river and they appeal to the Court for legal protection. The BWDB is responsible for the protection of the river-bank from erosion and for construction of the embankment. The DCC, having the authority to issue trade licenses, leased out part of the south bank of the Buriganga River downstream of Mirpur Bridge to private traders for unloading construction materials such as stone chips, boulders, gravel, sand, bricks and wood; these traders also encroached a substantial portion of the river (Shams, 2000). During my field visit on 26.6.01, I observed that a group of traders had acquired a 'lease' from the Ministry of Energy and Mineral Resources to extract sand from the Buriganga River near the China-Bangladesh Friendship Bridge threatening the existence of the bridge. The DWASA has installed several regulator and pumping stations on the river-bank to drain out rainwater from the city to the river. It also operates a surface water treatment plant and a sewage treatment plant on the bank of the river. Being common property, there is no restriction on using any resources of the river (e.g. bathing, fishing, boating and withdrawal of water) for non-commercial purposes.

Any action for improving the health of the Buriganga River involves effective co-ordination, as well as participation, of the stakeholders. The Buriganga River thus represents the emerging problems and threats rivers in Bangladesh are now facing. The cleanup of the Buriganga River deserves immediate attention. There are at least five reasons for the river cleanup programme in Bangladesh to start with the Buriganga River.

First, recently some civic groups have been able to mobilize people's support against unabated pollution and illegal encroachment of the Buriganga River. For example, *Bangladesh Paribesh Andolon* (Bangladesh Environmental Movement/BAPA), a platform of some non-government organizations (NGOs) working in the area of the environment and civil society groups, is playing a unique role both as a pressure group to the regulatory body and in creating awareness among the public[12]. For the success of such a cleanup programme, community support and participation is considered vital. So, it is the right time to undertake such a sensitive programme.

Second, encroachers and polluters, to some extent, take advantage of the lack of proper and enforceable rules and regulations. The case of the Buriganga River can be used to frame such rules and regulations.

Third, the knowledge and experience of the Buriganga River can be replicated to other places throughout the country where rivers, lakes and wetlands are threatened.

Fourth, groundwater arsenic pollution has emerged as a great environmental problem in many parts of Bangladesh. Because of excessive use of ground water and the mounting population in Dhaka City, the supply of drinking water has become a major problem[13]. Experts believe that increased use of surface water is inevitable in the future[14]. On the basis of projected demand and supply, experts reveal that the age of ground water dependency is near to an end. Unless alternative sources of water are tapped, a severe water crisis is imminent. Considering practical options for surface

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[12] It has organized many rallies, sit-in demonstrations, drawing competitions for children, boat races on the Buriganga River and seminars/symposia.

[13] Although the demand for water in the city is increasing at the rate of six percent annually, many areas within Dhaka City have become unsuitable to sink new deep tubewells (Kader, 2002). Also, the annual withdrawal of ground water is more than the recharge.

[14] Although the water supply in Dhaka City started in 1874 with the construction of a surface water treatment plant at Chadnighat on the bank of the Buriganga River, since then no such initiative has been taken to use surface water for this purpose. Due to some major advantages over surface water such as minimal contamination, non-variation in quality, ease of abstraction and constant supply, use of ground water has become the only source of the ever increasing water demand of the city dwellers. Now the exploitability of ground water has become a big concern. A recent study shows that the ground water level inside Dhaka is decreasing continuously each year. For example, in some locations the draw down rate is about 0.75m/year (Islam, 1996).

water availability, use of river water, particularly of the Buriganga, for household and industrial purposes, could solve the emerging water crisis in Dhaka City[15].

Fifth, by using the Buriganga River as a central theme, it is possible to develop an environmentally sustainable integrated city planning process where issues like waste collection, treatment and disposal, supply of pure and reliable drinking water, wastewater treatment, sanitation, drainage, tourism, recreation, and preservation and restoration of cultural, historical and heritage sites along the river could be planned in an integrated and sustainable fashion. Restoration and development of the Buriganga River is needed not only for water supply purposes, but also for an ecological balance and thus for a better environment.

The situation with the Buriganga River is not an isolated case but is typical for Bangladesh and other developing countries. Due to the absence of water quality data for many rivers in Bangladesh, it is difficult to establish which rivers are threatened. The DOE and some other organizations have only recently started water quality monitoring. Longitudinal analysis of water quality data is difficult due to the absence of consistent data at the same monitoring points. Nandi (2001) identifies some dying rivers in the south-western region of Bangladesh, such as the Bhadra, Bhairab-Rupsha-Pashur, Dumuria, Garai-Modhumati-Baleswar, Harihar, Kamkura, Kapotakkho, Mukteswari, Nabaganga, Salta, Shailmari and Teligati. On the basis of available information and newspaper reporting (see Box 2.1 for some of the headlines from national daily

Box 2.1: Headlines from national daily newspapers about the vulnerability of rivers in Bangladesh

River raiders and polluters on the loose
Abu Shams
The Independent
February 18, 2000

Once there was a river: Ichhamati now a narrow stream
M. A. Khan

Tale of twin troubles: Vanishing lakes and rivers around capital
M. K. Majumder
The Independent
February 26, 2000

Turag: A river being grabbed
Naren Paul
The Independent
December 22, 2000

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[15] Studies about existing supply facilities and future demand analysis reveal that solely depending on ground water, it is no longer possible to meet the future water demand of Dhaka City (Islam, 1996). To allevate the city's present severe water crisis (DWASA can supply 1280 MLD water in the city daily out of the total demand of 1600 MLD), DWASA has already attempted to use two big rivers – the Buriganga and Shitalakhya. A water supply project named Saydabad Water Treatment Plant financed by the World Bank is being implemented. However, the World Bank once (in 2001) suspended its funding on the ground that the project would not prove viable because the waters of the river had become too polluted and would remain unfit for human consumption even after purification efforts (*The New Nations*, 22.10.01). This suspension was later withdrav [illegible] egotiation.

The Daily Star December 8. 2000	
Dhaleshwari drying up *The Bangladesh Observer* January 1, 2001	*Waste dumping by KMP, KPC pollutes Karnaphuli water* *The Financial Express* July 28, 2001
50 illegal structures on the bank of Karnaphuli in Chittagong *The Daily Prothom Alo* July 30, 2001	*Illegal structures reducing width, depth of Karnaphuli* A. A. Mahmud *The Daily Star* September 15, 2001
Deadly pollution of 3 rivers endangers lives of thousands *The Daily Star* February 7, 2002	*80pc of Bangladesh's 235 rivers are drying up* *Gulf News* February 16, 2002
Modhumati, Navaganga rivers in Narail dying *The Daily Star* March 7, 2002	*Industrial wastes polluting rivers in southern region* *The Daily Star* March 16, 2002
Stop dumping garbage into rivers *The Daily Star* November 16, 2002	*Save rivers from death* *The Daily Star* March 12, 2003

*Source: C*ompiled from Bangladesh daily newspapers.

newspapers), a number of rivers can be identified as vulnerable in Bangladesh. These are the Baleshwar, Balu, Betna, Buriganga, Dakatia, Dhaleswari, Ghagot, Gorai, Ichhamoti, Kabodakha, Karatowa, Karnaphuli, Kumar, Mogra, Old Brahamaputra, Rupsa, Shitalakhya, Surma, Tongi and Turag. It can be established that about one third of the country's rivers, particularly those passing through big cities, are vulnerable to one or more of the threats identified in the previous section. Among these vulnerable rivers, the worst problems in terms of pollution and encroachment are in the Buriganga River.

Not only are rivers in Bangladesh vulnerable, many rivers throughout the world are exposed to and affected by natural, external, human-made and climate change-related problems. Russell *et al*. (2001) list a number of rivers in Latin America and the Caribbean suffering from depletion of ambient water quality, such as zero dissolved oxygen levels (in the case of Argentina's Reconquista River, Brazil's Tietê River and Colombia's Bogota River), bacteriological contamination (in the case of the Rio Grande de Tarcoles in Costa Rica), and contamination with toxic substances (in the case of Brazil's Paraiba River). Some further evidence of ailing rivers both in developing and developed countries is provided in the next chapter when reviewing the existing literature on river cleanup activities, interventions to save them and application of non-market valuation techniques.

Choe *et a*l. (1996) state that "[i]n most industrialized countries, cities built their sewer lines first and then later, when they could afford it, they built wastewater treatment plants. This staged approach improved public health conditions in cities because it removed the human waste from town. However, the rivers and lakes were often badly polluted by the discharge of untreated wastewater" (p: 521).

Considering all these, the Buriganga River has been selected as a case study for this research in order to monetize the benefits of the cleanup and integrate these into the decision-making process. The problems the Buriganga is facing are not only representative of the other rivers in Bangladesh, but also of many rivers in the world – both in developed and developing countries.

2.2.1 The Buriganga River System

Dhaka, the capital of Bangladesh, is surrounded by six rivers: Balu in the east, Tongi (locally known as *Tongi khal*) in the north, Turag in the west, Buriganga in the west and south, Shitalakha in the south, and Dhaleswari in the east, as shown in Map 2.4.

The Buriganga River system is located in the southern part of the North Central Region of Bangladesh, close to the confluence of the Padma (Ganges) and Upper Meghna Rivers (see Map 2.4). Hydrologically, the Buriganga River is not an isolated river – many other rivers are connected with the Buriganga and influence its flow. It is hydrologically connected with Balu, Dhaleswari, Kaliganga, Karnatali, Shitalakhya, Tongi Khal and Turag. The surface water system of Dhaka, comprised of several

Map 2.4

depression storages (e.g. roads, lakes and submerged low-lying lands) and khals (canals), is linked to these surrounding rivers. The city rainfall is accumulated in the depression storage and discharges to the surrounding rivers through the khals. The monsoon flood in the periphery of the city is liable for the back water flow from these rivers. These rivers contribute to the groundwater recharge to the city aquifers. Therefore, the hydrology of Dhaka City is heavily influenced by the surrounding rivers. The network of the river system hydrologically connected with the Buriganga is shown in Map 2.5.

The influence of the Buriganga River on groundwater levels is an important component of the overall water balance of Dhaka City. The fact that, with comparable abstractions, piezometric decline is less in old Dhaka (close to the river) than in areas further from the river, such as Motijheel, indicates that much of the volume abstracted by tubewells close to the river originates from the Buriganga River (Shahabuddin, 1996). The ground water level of Dhaka City also exhibits large fluctuations between monsoon and dry seasons (*ibid*). Therefore, the distinct seasonal fluctuations of the water level in piezometers located near the river and the fact that there are almost no seasonal fluctuations in central Dhaka City indicate that the Buriganga River system surrounding Dhaka City is a vital source of ground water.

The Buriganga River encompasses the south-western periphery of Dhaka City (see Map 2.3). It originates from Dhaleswari from north of Dhaka and meets it again south of Dhaka City[16]. The Turag River falls into the Buriganga after Amin Bazar Bridge at Mirpur. The upstream of the Buriganga above the confluence of Turag used to contribute substantially to the flow in the Buriganga River. In recent years, this portion of the river has silted up and during the lean period, the flow at Turag is the main source of discharge through the Buriganga. The Buriganga is a tributary to the Dhaleswari River, which, after the Old Brahmaputra River, is the largest river in the north Central

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[16] In fact, the origin of the Buriganga River is from Brahamaputra-Jamuna. The Lohajang River branches off from the Jamuna north-west of the Tangail district and the Dhaleswari River branches off seven kilometres to the south-west. These two join near Ealashin and flow south-east as the Dhaleswari River. The Dhaleswari bifurcates and the southern arm flows south of Manikganj and joins the main stream, which flows north of Manikganj 48 km to the south-east. This southern arm, named the Kaliganga River, now carries more water than the Dhaleswari. Just north of their confluence the river again bifurcates, the southern arm retaining the name, while the northern is called the Buriganga River (Rashid, 1991).

Map 2.5

Region of the country. The Shitalakhya (or Lakhya) River joins the Dhaleswari, 11 km downstream of the Buriganga confluence. The Dhaleswari drains into the Meghna River, just upstream of the Padma confluence. All these rivers except the Dhaleswari and Turag are very small. The length of the rivers is shown in Table 2.2.

Table 2.2: *Length of surrounding rivers in Dhaka City*

Name of rivers	Length (km)
Balu	13
Buriganga	17
Dhaleswari	58
Shitalakhya	23
Tangi	14
Turag	75
Total	200

Source: Rahman and Rana, 1994: 65.

The upstream end of the Buriganga is 11 km down from the Mirpur Bridge and the downstream end is at Hariharpara. The total length of the Buriganga River is 17 km and its average width around Dhaka City is nearly 500 m. The average flow during the wet season (June to October) is about 700 cubic metres and during the dry season (November to May) about 140 cubic metres (Rahman and Rana, 1996).

The Buriganga is fed mainly by the Turag River, which receives flows from local rainfall and spill flows from the left bank of the Jamuna River. The Shitalakhya River drains a large catchment lying between the central forested areas and the Old Brahmaputra. Additional inflows to the system originate from the Balu, which drains a small catchment to the west of the Shitalakhya, and from the Ichamati and Karnatali Rivers, which mainly carry spills from the Padma and Jamuna Rivers respectively (Kamal *et al.*, 1999).

Generally, the flow of the Buriganga River is non-tidal during the wet season and tidal during the dry season. If the backwater effect is strong and upstream flow small, then sometimes in the wet season, the flow in the Buriganga becomes tidal. The tidal range, however, is not high; between 6.0 and 8.0 m.

The drainage of the City mostly depends on the water levels of the peripheral rivers. The major drainage channels (locally known as khal) in the City are Dholai khal, Gerani khal, Segunbagicha khal and Begunbari khal, which collect catchment runoff as well as wastewater and drain to the peripheral rivers, mainly to the Buriganga. The

Buriganga River is also important as the only source of surface water supply at Chadnighat and the wastewater treatment plant at Pagla, both on its bank.

2.2.2 Water Quality of the River

Water quality is determined by a variety of parameters. Often these are interrelated, and many vary seasonally. Water quality data for selected parameters were compiled from the Department of Environment for twelve months (January to December) in 2000 and Kamal *et al.* (1999) (see Table 2.3).

The sampling points of the DOE in the Buriganga River are Mirpur Bridge, Hazaribagh, Kamrangir Char, Chandni Ghat, Sadar Ghat, Farashganj, Dholai Khal, Bangladesh-China Friendship Bridge and Pagla (discharge point). Table 2.3 presents a summary of data on water quality parameters for the Buriganga River and a comparison with the Environmental Quality Standards (EQS) set by the DOE for inland waters in Bangladesh.

Eleven basic parameters of water quality are analyzed in Table 2.3. The standard practice for measuring the biochemical oxygen demand (BOD) involves testing the oxygen demand over a five day incubation period in the laboratory at 20^0C. The five day test (BOD_5) determines the amount of oxygen used up by the micro-organisms in the water in the first five days of recovery. Another measure of the oxygen demand is the chemical oxygen demand (COD), which is defined as the amount of oxygen necessary to chemically oxidize the waste material. Both oxygen demand measures indicate that not only does the value exceed the Bangladesh standard set for water, but the river is also in bad shape in terms of pollution load.

Table 2.3 shows that the concentration of chloride (as high as 1100 mg/l) in the Buriganga River is much higher than the tolerable limit. As the level of salinity varies significantly from fresh to salty, it has an impact on the aquatic life and varieties of species it can support. The chromium concentration in the Buriganga River near Hazaribagh was found to be 0.232 mg/l against the recommended value of inland water of 0.05.

The minimum limit for dissolved oxygen (DO) is 5 parts per million (ppm). Levels below this are fatal for any species of fish and other aquatic life in the river. The minimum concentration of DO in the Buriganga River was found to be 2 mg/1, which is far below the allowable limit for recreational and fishing purposes. Most importantly, it also indicates that aquatic life is difficult to support, hence the river is dying biologically.

***Table 2.3:** Water quality of the Buriganga River (January to December, 2000)*

Parameters	Environmental Quality Standard for fishing & recreational water	Measured water quality value	
		Minimum	Maximum
Biochemical oxygen demand	≤ 2	0.7	24
Chemical oxygen demand	0.05*	4	36
Chloride	100-600*	15	1100
Chromium**	0.05	-	0.232
Dissolved oxygen	≥ 5	2	8.5
Electrical conductivity	-	132	762
*Escherichia coliform***	0	10	55000
pH	6.5 –8.5	4.72	12
Total coliform**	0	125	80000
Total dissolved solid	1000*	80	1825
Turbidity (JTU)***	10 *	25	110

Notes: Figures are in milligrams per litre (mg/l) except electrical conductivity (measured by micro.mohos/cm), total coliform and *escherichia coliform* (both measured by nos/100ml) and turbidity (measured by JTU).

* indicates standard for drinking water.

** 1999 values shown

*** JTU: Jackson Turbidity Unit.

Source: Compiled from *Tabulation of Results of Water Analysis*, Dhaka Division, DOE; Kamal *et al.* (1999) and DOE (1997a).

Electrical conductivity (EC) is a measure of salinity content in water. The high value of EC indicates the presence of salt. Concentrations of chloride above 600 mg/l also renders the water salty.

Faecal pollution of waters is measured by *escherichia coliform* (*E. Coli*) and total coliform. As per the EQS, the acceptable limit of both total coliform and *E. Coli* is 0/100ml[17], whereas as much as 80000/100ml and 55000/100ml of total coliform and *E.*

17 Although 0/100ml is the standard value of *E.Coli* for Bangladesh water as per the EQS, Tebbutt (1998) asserts that "[t]here is considerable evidence that waters with up to 1000 *E. Coli* per 100ml can be supplied to rural communities with little or no health hazard to the resident population" (p: 263). The levels of *E. Coli* in the Buriganga River, however, exceed this level by far.

Coli respectively were found in the Buriganga water. These levels pose health hazards for people using the water for consumption and recreation.

The acidity and alkalinity of water is expressed in terms of pH value. It is measured on a scale of 0 to 14; pH 7 is neutral, a solution below pH 7 is considered acidic and above pH 7 alkaline (Tebbutt, 1998). A low pH value (<5.0) of the Buriganga River water indicates untreated industrial wastes, producing adverse effects on aquatic life by altering the available plant nutrients. The overall pH value of the Buriganga River ranges between 4.72 and 12.0, which indicates that the river water is not good enough for drinking and fishing purposes. The water in the Buriganga River is of varying quality – from high levels of alkalinity to medium levels of acidity.

Total dissolved solid (TDS) comprises inorganic salts and small amounts of organic matter (Ahmed and Rahman, 2000). Turbidity occurs in most surface waters due to the presence of suspended clay, silt, discharges of sewage or industrial wastes, algae and micro-organisms (Tebbutt, 1998). Data on both TDS and turbidity indicates that the river is highly turbid and loaded with solid residues, which was also visually observed during visits to the river.

All the parameters indicate that the water quality in the Buriganga River is worse than required standards, particularly in the dry season when all the values exceed the tolerable limit due to the low dilution factor created by the low flows in the river. During this time the tidal nature of the flow causes the pollutant to move in both directions and leads to a worsening of the problem. The river turns deadly for fish and other organisms during this lean season. Once the level of water quality parameters drops to such an extent and the fish and other aquatic species die, it is almost impossible for the river to recover later on.

This analysis of recent water quality data reconfirms the findings of some other studies, e.g. Chowdhury (1996), Reazuddin and Akhteruzzahan (1998), Kamal *et al.* (1999) and DOE (2001) that as a source of recreational, fishing and drinking water, the Buriganga River hardly satisfies the Environmental Quality Standards set out by the DOE.

Large amounts of floating debris, including dead animals and polythene bags, were observed during visits to the river. In many places, the water looks like discarded engine oil and has become gray and smelly (see Plate 2.1). The overall quality is very poor.

2.2.3 Uses of the River

Water is of fundamental importance for the ecology and the environment. However, this is not how the Buriganga River is perceived and used. Unlike other major rivers, the largest user of water from the Buriganga River is industry. This includes the plastic industry, dyeing, chemicals, saw mills, brick kiln, tanneries, aluminum units, pharmaceuticals, battery, washing, cold storage, steel and engineering, perfume, polybags and hospitals. Some other equally important uses are for domestic and municipal water supply, fishery and navigation.

With some possible exceptions, the river water nowadays is not used directly for drinking. The Dhaka Water and Sewerage Authority (DWASA) supplies water from the Chadnighat water works, established in 1874. However, as a source of bathing, swimming and washing of cloths, the Buriganga River water is still widely used (see Plate 2.2). During the field visits[18], water was found to be used both for washing of household items and cooking of vegetables and rice by families living as squatters along the river. A large number of country boats and shallow engine boats ferry passengers across the river and many mechanized vessels provide riverine communication with the remote districts (see Plate 2.2).

Although there is no big irrigation project that depends on the water of the Buriganga River, in the dry season people collect water locally for irrigation purposes, particularly on the south bank of the river.

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[18] Details about the field visits are discussed in *Chapter Four*.

Plate 2.1

Plat 2.2

Tens of thousands of people are employed in riverine activities in and along the Buriganga River. The loading and unloading of large cargo vessels are primarily done by labourers who move up and down with head loads of merchandise (see Plate 2.2). The Sadarghat terminal hums with the activities of passengers, boatmen, coolies and visitors along the four mile long river-bank. Boat and ship building and repairing have become an important industry along the Zinjira side (i.e. south bank) of the river. There is little fishing activity in the river because of the lack of fish (see Plate 2.2). Along the river-banks, clusters of country boats operate as floating hotels and shelters for itinerants, locally called *Badia* or *Bede,* who move from place to place in search of work as hunters, snake-charmers and folk healers.

The Buriganga River was once a fairly long waterway richly endowed with scenic and natural beauty. In the past, floating house-boats (restaurants-cum-residential hotels) moored on the water-front of the river formed a characteristic feature of city life, but are now reduced in number, standing among a medley of mechanized water vessels of various kinds. A few of them still exist, catering for meals from early morning till midnight and providing shelter.

A large number of people depend on the Buriganga River for their livelihood resulting in multiple adverse impacts. The major landuse along the banks is for residential and commercial purposes, e.g. bazaars, industries, storages and hospitals. Once the river was used for recreational purposes, such as walking along the riverside, fishing, boating and swimming. In 1864, Buckland *bandh*[19] (an embankment named after C. T. Buckland, the then Commissioner of Dhaka) was constructed to protect Dhaka City from flood and erosion from the Buriganga River and to create recreational facilities around the embankment. Coronation Park was also established on part of the *bandh*. It was traditional to welcome celebrities visiting Dhaka in this park. People used to visit this *bandh* for recreation and many facilities were established around it. In course of time, due to pollution, encroachment and unplanned development, most of these facilities are closed now. However, many people still use the river for swimming, bathing and boating (both for recreation and communication), although the water quality of the river is not suitable for such activities.

2.2.4 Sources of Pollution in the River

[19] The local term *bandh* means embankment.

Understanding the pollution sources of the Buriganga River is very important. Instead of using expensive treatment techniques for the improvement of the water quality and its overall health, the best option would be to cleanup the sources of pollution and prevent the river from becoming contaminated. The river is affected along its course by both point and non-point sources of pollution. These are discussed below[20].

(a) Point Source River Pollution

Point source (PS) pollution comes from a number of discharges including domestic sewage, industrial facilities and mismanagement of solid waste. Major point source stressors or pollutants are as follows:

Encroachment: The Buriganga River has been steadily shrinking and slowly dying due to actions from a number of influential quarters[21] engaged in encroaching and grabbing the river bit by bit. People have been grabbing the same river which has nourished their forefathers with its pure flowing waters and helped sustain life along its banks, provided protein to people, and drained out the dirt of city life to rejuvenate it. Dumping of garbage along the bank, apparently to reclaim land, has been practiced over the years. A visit to the river-front shows how structures built on platforms have sprung up along the banks of the dying river (see Plate 2.3). To consolidate their holdings, encroachers resort to large scale and indiscriminate dumping of wastes and garbages for landfill.

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[20] Sources of pollution have been identified through focus group discussions in the study area and visits to the river during the field work. Detail methods are discussed in *Chapter Four*.

[21] The encroachers are not only politically and socially influential people, the list also includes organizations like Sena Kalyan Sangstha (Army Welfare Organization/SKS) at Shyampur and Police Camp at Badamtali Ghat. The SKS has encroached upon 600 feet by 160 feet of foreshore and 97 feet by 160 feet of main channel filling about 2.15 acres of the river by dumping 2.5 million cubic feet of earth to build godown and berthing facilities for vessels without any permission either from BIWTA which is the official custodian of the shore, foreshore and the channel of the river or DOE for environmental clearance as per the ECR 1997 (*The Daily Star*, 18.8.2000). The encroachers' list prepared by the DOE even includes legislators.

Plate 2.3

The DOE undertook a survey in 1997 along the bank of the river and identified 113 illegally raised installations which encroached upon the riverbed, leading to its slow death (DOE, 1997b). Among the installations, there were households, mills and factories, dockyards, mosques and madrashas (religious educational institution), dyeing and textile mills, saw mills, depots for fruits, vegetables, bamboos and timbers, wholesale markets and multistoried buildings. Most of the installations were found to encroach upon land at the river and discharge all their wastes directly into the river.

Dhaka District Revenue Administration, in another field survey (DDRA, 1998), identified 244 encroachers, grabbing about 50.10 acres of land in total on both sides of the river as well as on the riverbed. In 2001, the BIWTA identified 304 encroachments along the 17.5 km long waterway, the shore and foreshore which are under its jurisdiction and warned that if these 'deadly obstacles' are not removed the river is 'sure to die'[22]. The major encroachments identified by the BIWTA along the Buriganga included permanent buildings, markets, mosques, industrial units and educational institutions. *Semi-pucca* houses with tin-roofs, thatched houses and open space with boundary fences have also been included in the list of encroachments.

These installations along the bank of the river are one of the major causes of and concerns for deterioration of the environment in and around the Buriganga. A number of slums and shanties also sprang up on the bank of the river, either on private land and illegally occupied *khas* land or on the encroached land of the Buriganga River (Plate 2.3). Encroachments, along with installations/establishments along the river, are the major point source of pollution. These are not only shrinking the channel and obstructing the flow of water, but also directly discharge different types of wastes into the river.

Solid Waste: Dhaka City suffers particularly from poor solid waste management practice. The Dhaka City Corporation (DCC) area, about 5.38 million people within an area of 360 sq km, generates about 3500 metric tons of solid waste per day (on an average 0.5 kg per person per day). Of this, 1800 tons are collected and dumped by the DCC, 900 tons go to backyard and land filling, 400 tons are on road side and open space, 300 tons are recycled by the rag pickers, and 100 tons are recycled at the generation point[23]. Although the DCC collects about 50 percent of the solid waste

22 Personal communication with the concerned officer of the BIWTA.

23 Personal communication with the concerned official of the DCC.

generated in Dhaka City, it does not have any sanitary landfill for ultimate disposal of solid waste. Solid wastes are basically dumped in the low-lying areas in and around Dhaka City and many are close to the river (e.g. Lalbagh, Mohammadpur, Aminbazar and Rayerbazar). A large amount of leachate percolates through the surface and contaminates the ground water. In addition, the least expensive method of municipal solid waste disposal practiced among many residents is to place it on the streets. Part of this waste ultimately finds its way into the rivers through rainwater runoff (see Plate 2.4). The city is currently suffering from the effects of highly toxic clinical wastes from a number of pathology centers, hospitals and clinics. Over 500 clinics and hospitals dump around 50 tons of waste daily, 20 percent of which is infectious and hazardous[24]. Indiscriminate disposal of solid wastes including organic wastes from different *kaucha* bazaars, factories and shops aggravates the situation. Many landfill areas are either close to the Buriganga River or drainage channels, which ultimately meet the river (see Plate 2.4).

The lack of waste management in Dhaka City has direct implications for the Buriganga River water quality. Build up of solid waste in the river, particularly through the city, impedes flows and thereby causes serious environmental problems, as well as compounds flooding. The crude dumping of solid wastes in low-lying areas has considerable environmental consequences resulting in surface and groundwater pollution[25]. In addition, the settlers residing in riverside squatters, poorly served by solid waste collection facilities[26], generally dispose of their solid waste directly into the river, which not only reduces the river's conveyance capacities, but also leads to a deterioration in water quality. As a whole, solid waste in Dhaka City is considered one of the major point source pollutants to the Buriganga River.

[24] Personal communication with the DOE.

[25] An analysis of leachate samples collected by drilling bores from five dumping sites shows potential of contaminating the groundwater – a very high concentration of BOD, COD, cloride and faecal coliform, and a number of toxic heavy metals including lead and chromium (Rahman, 2001).

[26] In many cases, a total absence of solid waste disposal systems was found among the riverside squatters which compels them to simply dump wastes either in the river or onto the river-bank.

Plate 2.4

Untreated Sewerage: According to the Dhaka Water and Sewerage Authority[27], the volume of waste being generated within Dhaka City is about 1,040,000 m^3/day. Out of this, only 120,000 m^3/day (11.54 percent) is under the scope of a modern treatment system. Only about 30 percent of the area and 20 percent of the population in Dhaka City are covered by these treatment facilities. Amongst the rest, 40 percent of the population employ their own treatment systems using septic tanks. Although a septic tank system is a type of sewerage treatment system, many septic tanks do not work properly due to lack of proper design and use. About 15 percent of the population, particularly slum-dwellers and low-income households of Dhaka City, use pit-latrines. In total, about 75 percent of the population of Dhaka City have access to some types of sewerage treatment system. The remaining 25 percent do not use any sewerage treatment facility; they use either open latrines or no latrines at all. A significant portion of the sewerage wastes of the people who use some types of latrine is being disposed either directly or indirectly (through different canals and open and low-lying areas) to the Buriganga River. During the field visits, it was observed that many sewer lines in the city ended up in the river (see Plate 2.5). Hence even sewerage lines are being used for dumping solid waste into the river.

Many industries and factories discharge effluents into drains and canals which subsequently find their way to the river. Sewer pipes are broken in many places, and thus solid wastes enter into the sewer lines. In many areas, surface drains are connected to the sewer lines for disposing of liquid wastes from septic tanks, although such drainage is supposed to drain only wastewater from kitchens into the rivers and canals through low-lying areas. Untreated urban sewage discharge is considered to be another major cause of water pollution in the Buriganga River. The very low quality of the river water in turn contributes to poor hygiene along the river corridors and loss of biodiversity in the river itself.

Industrial Pollution from Hazaribagh Tannery: The tannery is one of the most polluting industries in Bangladesh, although it is one of the major export earners. Leather and leather products rank fourth in earning foreign exchange and earned

[27] Personal communication with the concerned officials of the DWASA.

Plate 2.5

US$1,583 million in 2001 (MOF, 2001). Out of 270 registered tanneries in the country, about 250[28] are located in a small area of 25 hectares in the Hazaribagh in the heart of Dhaka City. Leather processing involves a series of chemical operations. Both chromium and vegetable tanning processes are used in the production process. In the tanneries, 85 per cent of the hides (mainly cow) are processed by the chromium tanning process, and the remaining 15 per cent (mainly goat hides) by the vegetable tanning process. Both these tanning processes generate large quantities of liquid and solid wastes, most of which directly or indirectly find their way to the Buriganga River (see Plate 2.6). According to the DOE estimate, more than 16,000 cubic metres of highly toxic waste from the Hazaribagh tanneries flow first to low-lying areas and then to the Buriganga River every day[29]. The wastewater is usually characterized by high pH, high suspended and dissolved solids, high BOD and COD, strong colour and potentially toxic compounds, such as chromium. Moreover, leather processing generates a significant quantity of solid wastes – about 115 tons per day. Only part of it is disposed by the DCC and the remainder litters the Buriganga River and its surrounds. The disposal of solid wastes from the tanneries generally creates a problem because of the quantity and the composition (i.e. non-biodegradable and toxic compounds). This waste contains sulfuric acid, chromium, ammonium sulfate, ammonium chloride and calcium oxides that may seep into the groundwater (Kazi, 1999). Also, odours produced by these chemicals and wastes affect the health of the people in the surrounding areas (see Plate 2.6).

Previously, tannery effluents remained stagnant in the low lands inside the Dhaka Flood Protection Embankment. For the last four years, the effluents have been released without any treatment through large underground pipes (sluice gate no. 7 and 8) into the Buriganga River. The sludge containing high levels of chromium is also being deposited on the riverbed and is polluting the water. During the field visit, the effluents containing chemicals from the tanneries were found to be gushing out of the pipes and creating white foam in the river water. The water of the river turns septic under the huge burden

[28] As in June, 2001, 149 are in operation.

[29] Personal communication with the concerned officials of the DOE.

Plate 2.6

of effluents from tanneries, particularly in the dry season.

Other Industries: The DOE, in a survey in 1998, identified 249 industries along the bank of the river responsible for water pollution from industrial sources of pollution. Other than tanneries, many industries, such as aluminium, dyeing, plastic, iron and steel, metal, pharmaceuticals, battery, washing, hardware and cold storage units are located on the bank of the Buriganga. They discharge their waste (both solid and waste water) directly into the river. Many small industries and factories located in the vicinity of the Buriganga River discharge in the local drains and subsequently into the river. Since the beginning of the development of small and medium industries in the 1960s, hundreds of small, mainly home-based industries have grown up either on the bank of the Buriganga River or close to it. All these establishments discharge effluents. Therefore, the results of these small land use decisions have a large cumulative impact on the Buriganga River.

Terminal and Landing Stations: With more than a hundred launches arriving and a similar number leaving the Sadarghat Terminal on the bank of the Buriganga River every day, it is one of the busiest river ports in the country. Due to the lack of railways and the inadequate capacity of road communication between Dhaka and most parts of the southern region, people depend heavily on the river route through this terminal for passenger and cargo traffic. However, it lacks a proper waste disposal system. Shadarghat Terminal discharges much solid and petrochemical waste into the river. In addition, there are spills from loading and unloading of house building materials such as cement, sand, rods and brickbats which are carried to many places along the river-bank (see Plate 2.7). The bank of the river near Amin Bazar (upstream of the Buriganga) has now been turned into a centre for making and grinding of pebbles and stone boulders. In many places along the river, solid waste and materials are seen to discharge directly into the river, particularly with rainwater run off (see Plate 2.7).

Unplanned Development along Riverside: Dhaka City lacks any land use planning. Although RAJUK embarked on a long-term Master Plan titled *Dhaka Metropolitan Development Plan (1995-2015)*, in reality it is hardly followed. It has been revealed that the DCC, the custodian of Dhaka City, itself continuously violated the Master Plan and has built commercial markets one after another, converting a children's

Plate 2.7

park, public park, open space, playground and others without any approval from the RAJUK[30].

As a result of this massive urbanization and population growth, the Buriganga River along with other peripheral rivers has been heavily affected. The river-bank is densely populated because of opportunities for business and trade and easy communication. Many slums have been erected mainly on the land grabbed from the river. After constructing eight km of Dhaka Integrated Flood Protection Embankment from Mohammadpur to Mitford, squatters have been constructed along the embankment. These slums and squatters lack civic facilities and dwellers directly send solid and liquid wastes into the river (see Plate 2.5). Hanging latrines along the bank of the river or on the river dump human waste (excreta) into the water.

The natural recharge of the river has been reduced due to an increase in the paved area, and either infill or conversion of open space, playgrounds and wetlands into residential and commercial establishments in the city (see Plate 2.7). The finding of a recent study conducted by the Bangladesh Agricultural Development Corporation shows that the city's ground water level is declining and is mainly concentrated in the city center where concrete coating prevents recharging of the groundwater by rainwater (Roy, 2003). In recent years, storm sewer drains have been constructed on many open drains which is also affecting groundwater recharge.

Overloaded Pagla Sewage Treatment Plant: The Pagla sewage treatment plant can process around 30 percent of its collected sewage. The remainder is being drained to the river without any treatment.

Some **other point sources,** in addition to the sources mentioned above, are also responsible for affecting the river. These include:

- Disposed solid waste and wastewater from floating restaurants at Shadarghat;
- Oil leaked from floating oil-seller boats;
- Petrochemical waste from boats and launches;
- Dockyards at Keranaging and Kaliganj;
- Fruit and vegetable depots/storage at Shambazar;

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30 Recent press reports provide evidence that it is the RAJUK which also deviates from its own Master Plan. Recently, changing land-use pattern of the Hatir Jheel, one of the few remaining wetlands in the city, the RAJUK has flouted the Master Plan and allowed commercial development on an area of 13 acres (Khan, 2002).

- Shipbuilding industries on the south side of the river (Keraniganj);
- Bazaars/shops located near the river;
- Saw mills located at Farashganj and Faridabad;
- Discharges from sluice gates along the Dhaka Integrated Flood Control Embankment;
- Discharges (both waste and storm waters) through many canals and drains linked with the river;
- Hanging latrines along the river;
- Brick kiln;
- Hospitals; and
- Indiscriminate stacks of sand quarrying from the Buriganga River and grinding of pebbles and stones on its bank at Postogola, Hasnabad and Rayerbazar.

All these point sources of pollution are diverse in nature and very substantial in terms of impact on the Buriganga River.

(b) Non-point Source River Pollution

Degradation of water quality by non-point source (NPS) inputs is an important phenomenon and urgent attention is required in reducing NPS inputs to receiving river waters.

The NPS pollution comes from many diffuse sources. It generally results from land run-off caused mainly by rainfall, precipitation, atmospheric deposition, drainage, seepage and hydrologic modification. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into the river and other receiving waters and even the underground sources of drinking water.

Urban storm water runoff carries various pollutants washed off from streets, roof-tops and various types of land cover. It is revealed that the city storm runoff with very high pollutant loads[31] is directly discharged into receiving water bodies threatening the natural aquatic environment (Rahman and Chowdhury, 1999). However, this is not unexpected considering the developing nature of the city and the poor waste

[31] Storm water quality was monitored during the 1997 monsoon at three locations in Dhaka City, i.e. two at Elephant road and one at Zigatola. The parameters which were monitored are pH, dissolved oxygen, total solid, total dissolved solid, biochemical oxygen demand, nitrate (NO_3) and nitrite (NO_2). The pollutant loads were found to be considerably high (Rahman and Chowdhury, 1999).

management practices. Although there are separate sewer systems for carrying storm water within Dhaka City, the storm sewers often receive domestic wastewater causing an unwanted deterioration of the storm sewer discharges[32]. Moreover, the existing waste disposal practice and management of wastes are not organized in Dhaka City. Wastes are often disposed of at roadside open dumps which are very likely to be washed away by runoff to the storm sewer. These washouts are believed to produce a number of pollutants in the storm runoff. Many landfills within the city are open and close to drainage. Discharge from construction sites also adds pollutants to the runoff.

Pollution by **sediments** is another concern. Although there is no accurate estimate of sediment discharge to the Buriganga River, it is obvious that the river receives an enormous sediment flow both from its upper catchment and from the city. Experience indicates that sediment concentration/deposition due to human activities (e.g. cutting of trees, lack of vegetation on the top-soil, poor management of construction and digging of roads throughout the years) impacts the Buriganga River. Sediments are a major source of chemical pollution for the Buriganga due to the close existence of industries, particularly tanneries at the Hazaribagh.

Polythene bags have been identified as another hazard for deteriorating environmental quality in and around the Buriganga River. According to various estimates, about six million polythene bags are used daily in Dhaka City and only twenty percent are properly disposed of. The rest litter the roads, streets and everywhere and finally end up in drains and sewer lines, clogging these and creating serious water logging problem and blocked sewer lines in the city. Some of these polythene bags finally end up in the river[33].

The **rainfall pattern** in Dhaka has important implications for both sanitation and water pollution control. Data shows that Dhaka experiences a typical monsoon climate with high rainfall in the months from June to September and is relatively dry at other times. With regard to water pollution control, during the monsoon period the high flow rates in the rivers and flooding in the surrounding low-lying areas provide a large

[32] There are two reasons for this. First, in some areas, the sewerage service is non-existent. In those areas, residents, with the help of unscrupulous employees of the DWASA, connect sewer lines with storm water lines. Secondly, even if a sewerage service exists, the system is so over-loaded that it cannot carry sewerage properly. In this situation, residents also connect sewer lines with storm sewer lines.

[33] Recently the Government has banned marketing and use of polythene shopping bags in Dhaka City from January 1, 2002 and across the country from March 1, 2002, considering their adverse impact on health and the environment. Although such a ban was imposed earlier in 1994, it was withdrawn after lobbying from polythene producers.

dilution capacity for the river. This reduces the water pollution problems in the monsoon season. Conversely, in the dry season the lack of dilution capacity results in more severe water pollution problems in the Buriganga River.

In many countries, **agriculture** is the leading non-point source pollutant for rivers. Although increased use of fertilizers and agro-chemicals have become a concern for river water quality, in the case of the Buriganga, agriculture as a source of pollution has little impact. The entire north side of the Buriganga has now become urbanized. Vegetables are only being grown in a few spots, mostly with the use of organic manure. Very few agricultural practices were noticed during the field visits on the south side of the river. Agricultural runoff has an influence on the Buriganga River water quality only in the upstream.

Water pollution in the Buriganga River is the result of a variety of sources. Although many are small in terms of effect, the cumulative impact is large. Therefore, there is a need for an integrated approach to deal with pollution sources as they all end up contaminating the river.

2.2.5 Initiatives to Save the River

Since the 1970s, due to unabated pollution from industries, particularly tanneries, and population pressure along the river-bank, the Buriganga River has started to degrade and lose its glory. The problem of encroachment worsened the situation in the 1980s. Apart from a few newspaper reports, this has received neither any action on the part of administration nor any widespread public awareness, until recently. In the late 1990s, the problems of encroachment and pollution were subject to intensive media coverage.

In 1997, the Government formed a national committee headed by the Minister for Environment and Forest to take steps to ensure removal of illegal structures, maintain normal flow and 'beautification' of the river. In 1997, the DOE also undertook a project titled *Save the Buriganga* to monitor water quality and conduct a survey about the extent of encroachment. In 1998, the Dhaka District Revenue Administration (DDRA) carried out a survey on encroachment. In another move, the Government formed a committee in 1998 headed by the Minister for Ministry of Water Resources to review the existing laws and regulations, formulate appropriate regulations and find ways to evict illegal encroachers from five rivers including the Buriganga River. Again, on

October 26, 1999, the Government formed another committee to evict encroachers from the Buriganga River headed by the District Commissioner, Dhaka Zila.

All these committees sat several times and discussed the extent of problems and possible ways to find solutions, but nothing has happened yet. A conflict arose in 1999 as to who should be responsible for removing illegal structures from the river – the Ministry of Land, BIWTA or Ministry of Water Resources (*The Daily Janakantha*, 25.9.99). None of these departments were willing to shoulder the responsibility for action, and ultimately, nothing was done.

The BIWTA also conducted a survey on encroachment in 2000. There are substantial differences among the findings of BIWTA, DOE and DDRA in terms of number of encroachers and total area encroached (details are already discussed). In 2000, the Bangladesh Environment Lawyers' Association (BELA) filed a writ petition to the High Court seeking appropriate directives for the removal of illegal encroachments and recovery of public property. The High Court asked some government agencies to submit a report in the form of an action plan for removing illegal encroachments on the Buriganga River. Government agencies ignored the directive of the High Court at that time.

In 2000, some environmental activists launched a campaign titled *Buriganga Bachao Andolon* (Save the Buriganga Movement). Since then huge pressure has been exerted on the authorities to remove illegal encroachments and to stop pollution (see Plate 2.8). Except for promises from the administration and politicians, nothing had been done to improve the health of the river until 2001. It was only during the period of office of an interim caretaker government from July to September, 2001, that the BIWTA undertook an initiative to remove illegal encroachments. Many encroachers were removed from their illegal settlements at that time. After the expiry of the term of the caretaker government and the holding of a general election, the new government came to power in October 2001. Encroachers have resumed their illegal occupation on the river and almost all have regained their position with even more solid structures (*The Daily Prothom Alo,* 4.11.01). Politicians have again started to express new promises to save the river. On October 2, 2002, the Government constituted an 11-member taskforce, this time headed by the Minister of the Ministry of Shipping, to recommend necessary steps to save the river (*The Daily Star,* 9.10.02). The outcomes are yet to be seen. However, recent reports in the national daily newspapers reveal that the encroachment and pollution to the Buriganga River continue unabated (*The Independent*, 5.9.03; *The Daily Star*, 10.9.03 and *The Daily Star*, 15.9.03).

(a) Encroachment

(b) Demonstration against encroachments

Plate 2.8: *Encroachment and civil society movement*

© *The Daily Star*

In order to find out the reasons behind the failure of the initiatives earlier taken by the Government, concerned officials of the BIWTA, DOE, MOWR and PC were interviewed during the field visit. They stated that previous demolition/eviction efforts failed, although there were laws and regulations to remove illegal encroachment. These efforts were not only short-term in conception, but also were *ad hoc* in their execution because the removal of encroachments costs a lot of money which the agencies concerned lack. Authorities do not consider such activities as priority work. The demolition of a few illegal structures or part of squatter settlements created neither any dis-incentive to other encroachers nor provided any protection for the reclaimed land. Despite the demolition, these illegal structures re-emerged. Concerned authorities could not undertake any development activity, such as protection of river-banks, demarcation of shore land, dredging of riverbeds, improvement of water quality at source, solid waste management, treatment of industrial effluents and waste water and so on due to the lack of resources.

Demolition of illegal settlements alone will not solve all the problems the river is facing. Simultaneous intervention in the other areas, elaborated in this chapter, is required to save the river and create a better environment in and around it. From the policy decision-making perspective, the commitment of resources for such environmental improvement projects/programmes is always scant as the benefits of these investments are not ‘tangible’ or well-accounted for in the formal decision-making process. Although the country undertakes more than a thousand development projects each year through the ADP, there is a lack of appreciation among the policy decision-makers regarding the benefits of environmental improvement projects, such as cleaning up dying rivers like the Buriganga.

The Buriganga River represents a host of problems common to rivers both in Bangladesh and other countries. Furthermore, the funding problems for environmental improvement activities such as for the cleanup of the Buriganga River are not unique to Bangladesh. Russell *et al*. (2001) state that “it should be recognized that many developing country governments face tight budget constraints and difficult resource allocation choices in addressing a host of environmental and social concerns. One or two expensive, poorly chosen projects can preclude other, more socially desirable interventions, so a hard line is almost a necessary [sic] if one takes the rhetoric of sustainability seriously” (p: 8).

Therefore, the Buriganga River in Bangladesh has been chosen as a case study for this research as it is representative of a global problem concerning (i) the cleanup of dying rivers, (ii) estimating benefits of non-market goods and services, (iii) examining the desirability of undertaking the cleanup programme for dying rivers, and (iv) mobilizing investable funds from within the community.

2.3 Conclusion

This chapter has attempted to sketch the overall picture of the water sector, the river system and the Buriganga River in Bangladesh. As a lower riparian country, both the economy and the livelihood of Bangladesh are largely influenced by its water resources in general and river water in particular. The thousands of miles of rivers, which virtually lace and criss-cross the country, are the lifeblood of Bangladesh and its people. However, many rivers throughout the country are now under threat due to both human-made and natural causes. This calls for immediate intervention.

The impending water shortage due to the overuse of ground water, the growing population and the multipurpose demand in Dhaka City together mean that maintaining water availability in the Buriganga River, not only in terms of quantity, but also quality, has appeared as a major challenge for the existence of the capital city in the future. In this context, through describing the Buriganga River system, uses of the river, its level of pollution and sources of pollution, this chapter provides a “without programme” scenario which indicates that if an intervention is not taken, the deteriorating environment in and around the Buriganga River will worsen. The description also provides a background for defining interventions required to design a cleanup programme for the Buriganga River. This will be elaborated throughout the next chapters.

The kinds of problem rivers like the Buriganga face are multidimensional and require an integrated approach to solve. Not only do the concerned agencies lack adequate funds to carry out cleanup programmes, such activities are not a high priority as most of the benefits of such a cleanup are not 'tangible'. Although there are usually urgent short-term pre-occupations and competing priorities to contend with, it is equally true that investments in environmental improvement are ill-perceived in developing countries like Bangladesh. Therefore, if funds can be generated and the intangible benefits are monetized and incorporated in the decision-making process, this is expected to help change the situation.

Alam, Khorshed. (2003). *Cleanup of the Buriganga River : integrating the environment into decision making*. PhD Dissertation. Perth, Murdoch University.

Chapter Three
CONCEPTUAL AND THEORETICAL FRAMEWORK

3.0 Introduction

There are large environmental problems in developing countries and resources in most cases are insufficient. Environmental problems are considered unsurmountable. They are also not included in the decision-making process because of their nature (e.g. in most cases they refer to public or environmental goods) and the difficulties involved in presenting them in monetary terms, which is the language of decision makers within developing countries and aid organizations outside them. To a large extent this is also the case in developed countries, but there has been some progress in developing concepts and theories to assess the value of the natural environment.

Although there is a significant body of literature on the practical concepts and theories to monetize the value of environmental goods, there are controversies in regard to both methods and applicability in a particular situation[1]. Most importantly, these are developed in the context of western economy and culture, which, in many instances, are different from the developing world. Also, as Gabel and Folmer (2000) put it: "[a]lthough valuation is inherently an applied empirical process,… published studies have too often been flawed by insufficient regard for the theory on which they should be based" (p: xxxv).

This chapter introduces the economic theory that underlies the valuation of non-market goods and services and which can allow for the integration of environmental dimensions into the policy decision-making calculus. It constitutes the conceptual and theoretical core of the study and lays out the basic premises and value judgements which underlay the economic concepts of value. It also develops a framework which provides a basis for the decision-making procedure. Most importantly, it offers a new approach to measuring non-market benefits and thus integrating these benefits into decision making in the context of a developing country. Both the conceptual and theoretical frameworks for this study originate from neo-classical welfare economics.

[1] Details are elaborated later in this chapter.

This is not because it is an infallible or even necessarily the best approach, but because it is the dominant economic paradigm. Hence, if it is possible to work within it, it is likely that the changes will be faster and easier to implement and this is particularly important for a dying river like the Buriganga in Bangladesh.

This chapter also describes a survey of literature on the valuation studies undertaken in the area of water (river) quality improvement, specifies the hypothetical market for the current valuation exercise and identifies resources to be valued through the selected valuation technique.

This study is not about an econometric modelling or estimation. Rather, it focuses on how economic valuation of non-market goods can be incorporated into decision-making processes from the perspective of policy making. The context for both the theoretical framework and empirical analyses is developing countries.

The chapter is structured as follows: Section 3.1 describes conceptual issues in relation to economic values and total economic value. Section 3.2 analyzes the choice of valuation method and elaborates on the contingent valuation technique. Section 3.3 introduces a framework for integration of the environment into decision making and discusses decision criteria for the cost-benefit analysis. Section 3.4 reviews valuation studies on environmental improvement with regard to river cleanup, describes the contingent valuation scenario for environmental improvements and defines the benefits needed to be valued for the study. Finally, Section 3.5 concludes the chapter.

3.1 Conceptual Issues

The conceptual basis of total economic value to estimate total benefits of an environmental change along with its components is the main focus of the discussion to follow. Issues of public goods, the necessity of government intervention and the procedure for estimating total economic value are also discussed.

3.1.1 Meaning of the Concept of Value

The meaning of the word *value*[2] is central to the valuation of any resources. Economic valuation is the process of assigning monetary values to goods and services that are not traded and, thus, not priced at all or not priced correctly by markets. The

[2] The term value and benefit are used interchangeably throughout this study as in Imber *et al.* (1993) and Shechter *et al.* (1997).

concept of value has many different meanings in various disciplines and is often the "cause of semantic confusion" (Peterson *et al.*, 1990: 11). This study is concerned only with the economic definition of value which is one of the most commonly used bases for valuation, that is, the process of assigning values to an attribute. Peterson *et al.* (1990) refer to the economic definition of value as "the most rigorously defined concept and is derived from a well-developed framework of operational theory that not only interrelates concepts but also relates concepts to empirical phenomena" (p: 12).

Economic value is defined by economic behaviour in the context of supply and demand in the market. It is simply the amount of money individuals are willing to forgo (pay) in order to receive a good or service or state of the world, or the amount of money they are willing to accept in compensation for the loss of a good or service or state of the world. This sum of money is demonstrated or implied by the choices or preferences individuals make. Therefore, an economic value is regarded as a measure of utility of individuals in the society through the concepts of willingness to pay (WTP) and willingness to accept (WTA) compensation.

3.1.2 Total Economic Value: A Typology of Value

The economic concept of value is broadly defined as "willingness to pay" or "willingness to accept"[3] compensation for the changes in question. However, this concept does not restrict economic values from the direct use of a resource or a good. It is often argued that individuals not only value their own consumption of goods generated by the project or programme (environmental or public good), but the benefits that "individuals obtain in satisfying altruistic desires that arise from their own moral beliefs also have economic value" (Binning *et al.,* 1995: 17). Individuals may derive utility from the existence of a resource such as a recreation site, even if they themselves do not intend to physically visit the site. Therefore, from an economic point of view, values can be associated equally with the consumption of goods and services purchased in markets and with the utility or satisfaction from a good or service for which no payments are made (e.g. clean air or water) or even where there does not exist any market (e.g. aesthetic beauty and visibility). In this sense, anything from which an individual gains satisfaction or utility is considered to be of value, so long as the individual is willing to give up limited resources for it (Imber *et al.,* 1993 and Binning *et al.*, 1995).

3 Many define the concept of the WTA as "willingness to sell" (Harris, 1984 and Hanley, 1988).

These values constitute a broadly accepted taxonomy of values which, when aggregated, is called the 'total economic value' (TEV) (Munasinghe, 1993 and Young, 2001). The total economic value of environmental goods and services, in particular, is basically the sum of two types of values – use value and non-use value (Munasinghe, 1993; Barbier, 1994; Pearce and Moran, 1994 and Young, 2001). The components of both use and non-use values are described below.

Use values (UV) can be direct use value (DUV) or indirect use value (IUV)[4]. Direct use values are derived when an individual makes actual use of a resource (Georgiou *et al.*, 1997), for example, fishing in the river. Direct use values consist of consumptive uses such as fishing and use of river water for domestic and irrigation purposes; and non-consumptive uses, such as recreational activities which leave the condition of the resource almost unchanged (Barbier, 1994). Indirect use values arise from "the natural functioning of ecosystems" (Georgiou *et al.*, 1997: 25), such as flood protection or ability to dilute pollution to some extent through the assimilative capacity of the river.

Non-use value (NUV) is considered to be both difficult to define and measure. It is derived without direct use of a resource. Unlike use values, non-use values are independent of the individual's actual or planned/potential use of resources. Many argue that NUVs are important components of total economic value. For example, in specific contexts the non-use component can represent a large share of the total benefits as shown by Walsh *et al.* (1990) in their study of the preservation of forests in Colorado. Empirical evidence shows that in many cases NUV exceeds UV – Loomis *et al.* (1993) find NUV to represent 67 percent of total value and Stevens *et al.* (1991) find it to be 85 percent. In another study, Walsh *et al.* (1984) estimate non-use value at around 40 percent of the total value for preservation of wilderness areas in Colorado.

The NUV can be subdivided into existence value, bequest value and option value (Krutilla, 1967 and Randall and Stoll, 1983).

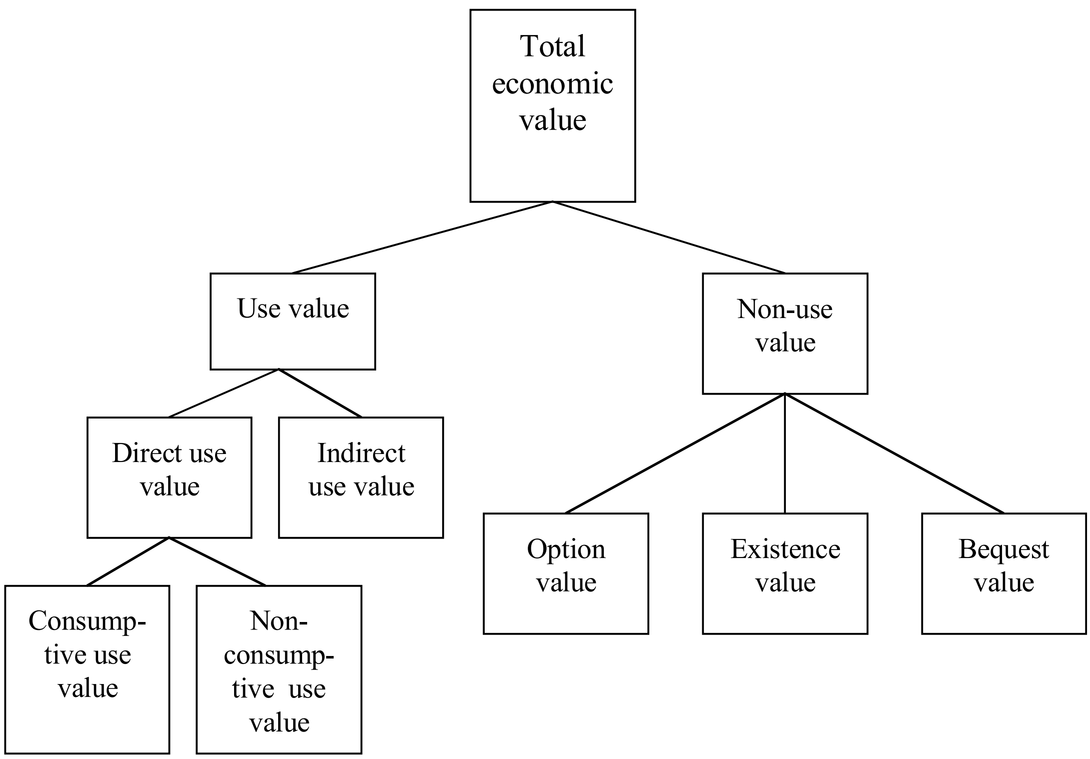
Non-use values (NUV) comprise:

- *Existence Value (EV)* – which measures the willingness to pay for a resource for some 'moral', altruistic or other reason that is unrelated to current or future use. Existence value arises from the benefit an individual derives from knowing that a resource exists or will continue to exist regardless of the fact that they have never seen or used the resource, or intend to see or use it in the future (Walsh *et al.*, 1984). For instance, respondents might be willing to pay to restore water quality in a polluted river only to know that good water quality exists there.

- *Bequest Value (BV)* – which measures people's willingness to pay to ensure that their descendants will be able to use a resource in the future (Brookshire *et al*., 1986). This is borne out of purely altruistic intentions. For instance, respondents might be willing to pay to restore water quality in a polluted river, neither for their current nor for future uses, but from knowing that their heirs and future generations will have good water quality.
- *Option Value (OV)* – which measures an individual's willingness to pay for the option of using a good or service at some future date, typically at a particular price (Weisbrod, 1964; Bishop, 1982 and Krutilla and Fisher, 1985). For instance, respondents might be willing to pay to take the opportunity to visit a restored river in the future.

The total economic value can be defined as the sum of the components shown in Figure 3.1.

Figure 3.1: *Taxonomy of total economic value*



[4] Some consider option value too as a component of use values (Munasinghe, 1993 and Panayotou, 1997).

Thus,

$$TEV = UV + NUV \tag{3.1}$$

$$\text{where } UV = DUV + IUV; \text{ and } NUV = EV + BV + OV. \tag{3.2}$$

The distinction/categorization among the components of TEV is not well-defined in the literature. For example, non-use value has been termed as intrinsic value (Yadav and Wall, 1998 and Asafu-Adjaye, 2000) or passive-use value (Carson *et al.,* 1995c; Carson and Mitchell, 1995 and Shechter *et al.,* 1997) or existence value (Carson *et al.,* 1992; Larson, 1993; McConnell, 1995; USACE, 1996 and Fuguitt and Wilcox, 1999). On the other hand, use value has been termed as instrumental value (Asafu-Adjaye, 2000). Some also term use values as "on-site benefits' (Bonnieux and Goffe, 1997) and non-use values as "off-site benefits" (Sanders *et al.,* 1990). Walsh *et al.* (1984) and Sutherland and Walsh (1985) use "preservation value" to refer to the non-use value and state that it is the sum of option, existence, and bequest values. Imber *et al.* (1993) include vicarious value and quasi-option value in the non-use benefit category. Young (2001) includes option and quasi-option values within the category of use value. Russell *et al*. (2001) consider the option value no longer as a separate category of value.

Although the precise distinction between use and non-use values is often not well-defined, the categorization described in the equations (1.1) and (1.2) above will be used in this study. The distinctions can also become irrelevant in practical estimation when the objective is to measure TEV rather than its components (Randall, 1991). This study uses both the use and non-use values in order to provide a complete picture of the issues related to a particular environmental problem.

3.1.3 Public Goods and Government Intervention

There is widespread opinion that markets are the most effective and efficient institutions to allocate scarce resources (Panayotou, 1993 and Gabel and Folmer, 2000). However, in reality ample evidence exists of cases where markets cannot produce socially desirable outcomes in terms of allocating resources. The case of public goods is such an example. A public good is characterized by the fact that it is non-rival and non-exclusive. Non-rivalry means that one person's consumption of the good does not affect others' consumption of the good, and non-excludability means that it may not be possible to exclude a person from consuming the good (Johansson, 2000).

Details about the characteristics of public goods are thoroughly discussed in the literature (Panayotou, 1993). However, when considering techniques to measure the economic benefit, it is important to remember that environmental quality improvement is a public good. Although some priced output (particularly some components of use benefits) is a private good in nature[5], markets are not well-established for such goods and services, particularly in developing countries like Bangladesh. Consequently, these are under-priced. Because the access to public goods (improved quality or provision of additional quantity) is non-rival and non-exclusive, many individuals can avail themselves of benefits without reducing their availability to others. The fact that people potentially can act as free riders, when goods are non-rival and exclusion is not exercised, helps explain why the benefits of environmental improvement, such as a cleanup programme for a river, lack direct market price analogues.

The absence of markets for environmental improvements does not mean that they are not economically valuable or such improvements do not bear any value. What it does mean is that there are no observable market prices for environmental improvement that can be related to observed levels of service use in order to estimate the demand function required for welfare measurement. To get around this problem, methods grounded in economic theory have been developed to estimate implicit prices associated with the varying use levels for non-market goods.

The role of measurement in the efficient allocation of resources is especially important in the case of public goods. Markets cannot efficiently allocate resources for public goods due to pervasive externalities, or for which property rights are not clearly defined. The observation that public goods are not efficiently allocated by the market suggests the possibility of improvement by public intervention. However, whether public intervention in fact yields net benefits requires measurement. An improvement in resource allocation requires that the benefits of an intervention exceed its costs, which in turn require the measurement of both benefits and costs.

3.1.4 Estimation of Total Economic Value

Defining the value conceptually is not a difficult task, but in reality the derivation as well as measurement of its components is a daunting task. Although use values can be readily measured by market prices and are well accounted for in the decision-making

[5] This will be elaborated later.

process, non-use values are problematic because they are not traded and therefore cannot be valued by market prices. Another caveat as Georgiou *et al.* (1997) explain is that "[w]hile the components of TEV are additive, care has to be taken in practice not to add competing values. There are trade-offs between different types of use value and between direct and indirect use values" (p: 8-9).

The measurement issue is further complicated as some components of TEV do not have established markets, particularly in the context of developing countries like Bangladesh. Theoretically, use values, particularly for consumptive uses, are expected to be valued using market data as markets exist for them, and this is true for almost all western economies[6]. However, markets are yet to be established for those kinds of use benefits in Bangladesh. For example, although information about the monetary value of clean water for consumptive uses such as irrigation, fishing, navigation or domestic uses, is available elsewhere (particularly in the western economies), such information does not exist in Bangladesh. Recreation or tourism has not been an industry until now. Although Dhaka City is surrounded by rivers, there are no facilities for water-sports or water-related recreation. Fishing in the rivers is a matter of "open access". The entrance for most historical sites and places of interest is free of cost. As a whole, a cleaner river, therefore, is a public good in nature although it is possible to establish private property rights for some of its components. Also, in some cases reliable data for quantification of benefits is absent. For example, data is absent either for existing or any projected figure of fish catch in the Buriganga River.

The lack of information about monetary value associated with many of the uses is a problem in Bangladesh. These goods are not traded in conventional markets, and in many cases, there is not even information available in related markets. In such a situation, information about the monetary value people have for improved environmental quality can be derived using non-market valuation techniques. These are described in the following section.

3.2 Choice of Valuation Method

This section describes different non-market valuation techniques and their applicability in a particular situation. It then provides details about the contingent valuation method chosen for this study, and its relevance for the problem being

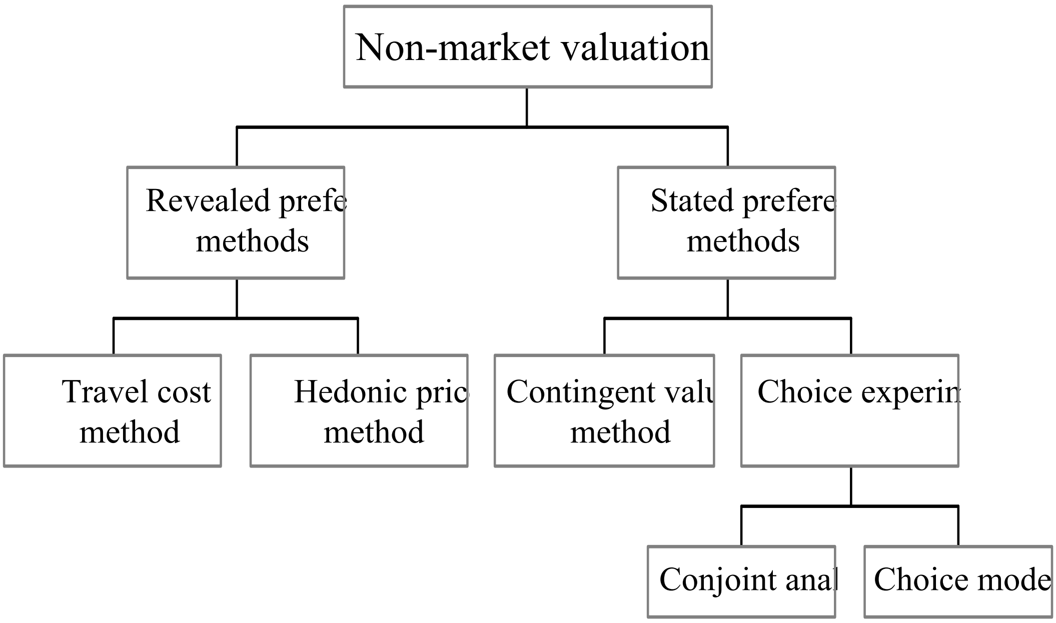
[6] For example, recreation benefits could be estimated from the recreational demand curve for the resources where visitors are charged fees for using publicly owned recreation areas.

analyzed. Most importantly, this section reviews the strengths and weaknesses of the CVM and then proposes a modification to encourage its better preference elicitation for respondents from the perspective of developing countries.

3.2.1 Non-market Valuation Techniques

A number of techniques have been developed to value non-market goods and services in monetary terms. A wide body of literature and empirical studies is available by now which documents these techniques and illustrates how they are related to a particular problem (Mitchell and Carson, 1989; Freeman, 1993; Pearce *et al.,* 1994; Winpenny, 1995 and Bateman and Willis, 1999). These techniques are shown in a schematic form in Figure 3.2.

Figure 3.2: *Non-market valuation methods*



A widely accepted classification of valuation methods distinguishes between revealed preference methods and stated preference methods (Asafu-Adjaye, 2000 and Shechter, 2000). Revealed preference methods involve inferring "an implicit value for a non-market good from observable prices of market goods and services, which are related in some way – as complements to or substitutes for the environmental good or service of interest. They are therefore based on observable market behaviour of individuals as consumers of these goods and services" (Shechter, 2000: 75). These methods are also referred to as indirect or surrogate market methods. Conversely, stated preference methods aim "at revealing valuations of and demand for an environmental good through consumers surveys where, through appropriately constructed questionnaires, individuals are asked to state their preferences for, or valuations of, the environmental good or service" (*ibid*). These methods are also referred to as direct or expressed preference methods. Different types of revealed and stated preference methods are briefly described below.

Revealed preference methods include:

Travel Cost Method: On the basis of observed consumption patterns, where people indirectly reveal their implicit valuation of the natural resource services through observable travel behaviour, the travel cost method (TCM) generates a demand curve for the recreational site under study. The TCM values a recreational site or characteristics by using the value of the time and other costs incurred in visiting the site as a proxy or for what a visitor would be willing to pay to visit the site. This method is employed "in studying the demand for, and value of, natural resources (national parks, natural reserves, open space), which serve as input services in 'producing' outdoor recreation activities and related amenities: hiking, camping, fishing, boating, swimming, wildlife-watching, and the like" (Shechter, 2000: 77). If the market for visits to a site is geographically extensive, then different potential visitors bear very different travel costs depending on their proximity to the site. The resulting difference in total cost and the differences in the rates of visits that they induce, provide a basis for estimating a demand curve for the site.

Hedonic Price Method: The hedonic price method (HPM) is employed to value environmental goods or services by using information from the prices of related market transactions (Asafu-Adjaye, 2000). For example, the price of a residence can be viewed as a function of its size, age of structure, physical condition, proximity to schools and quality of education, proximity to shopping centre, public transport or places of work, the quality of the environment in which it is located, and so on. Once data for each of the variables are available, econometric techniques are able to estimate the hedonic price function. This can reveal how much more households would be willing to pay for a property in a neighbourhood with improved environment, compared with an identical one in a polluted neighbourhood. Once estimated, the hedonic price function can be used to generate implicit marginal prices for each of the individual characteristics of the good. Like TCM, the HPM exploits the fact that "consumers reveal their valuation of the environmental amenities through their actual consumption behaviour in a market" (Shechter, 2000: 80).

Stated Preference methods include:

Contingent Valuation Method: The contingent valuation method (CVM) invokes a framework of a contingent (i.e. hypothetical or constructed) market used to elicit valuations both for market and non-market goods and services from individuals. This method is also referred to as the constructed market method. Under CVM, individuals are prompted to state their willingness to pay (WTP) for a change in the quantity or quality of the environmental good in question, or willingness to accept (WTA) a decrease of existing amenity or a damage. The CVM is by far and away the most common and widely used of the valuation techniques in practice. Pros and cons of this method will be discussed in the section to follow.

Conjoint Analysis: This technique is popular in marketing research. It has only recently been adapted for valuing environmental goods and services. In conjoint analysis, a set of attributes with a measurement scale is presented to the respondents who are asked to rank or rate the various combination options or to select the most preferred one from the set in a series of carefully conducted experiments. The data can be analyzed to estimate respondents' WTP for environmental goods or services.

Choice Modelling: In choice modelling, respondents are presented with a series of alternatives each containing a number of resource use options. Respondents are required to choose the most preferred alternative along with associated attributes from a choice set (Asafu-Adjaye, 2000). Using a logit model, estimates of individuals WTP for an environmental improvement can be measured. Unlike the other stated preference methods, it can be used to value multiple sites or multiple use alternatives.

This classification of non-market valuation technique is not unique. Asafu-Adjaye (2000) includes market value or cost methods and benefit transfer methods within the category of revealed preference methods. Shechter (2000) includes cost of illness method to estimate economic gains from improved health within the revealed preference methods. Russell (2001) lists a third type of revealed preference method, that is, averting behaviour, which infers a value for an improvement in environmental quality from changes in spending on ways to reduce the impact of the lower quality. Despite this lack of uniformity, what is pertinent is that there is a growing body of literature on the theory and application of economic valuation of non-market goods and services.

The choice of a particular economic valuation technique depends on the data, uses to be valued and resource availability as well as the particular context (the specific problem being studied). The section to follow addresses this issue for the case study in question.

3.2.2 Contingent Valuation Method

A valuation technique for this study (i.e. the Buriganga River cleanup programme) needs to be selected taking into consideration, among other things, the resources to be valued. Prior to choosing the valuation method, it is important to define the benefits needed to be valued for the BRCP. These are defined in more detail in Section 3.4.3 later in this chapter. In principle, the Buriganga River cleanup programme is expected to generate both market and non-market benefits. The market benefits are expected to be measured using market data/information. The non-market benefits need to be measured using one of the valuation techniques described above taking into consideration that the markets for them are either missing or not fully developed. The non-market benefits include both use and non-use values. Non-use values leave no behavioural trace. A valuation technique, without behaviour as a guide, needs to be chosen for this study.

The contingent valuation method is selected for this study for valuing the non-market benefits of the BRCP based on the data requirement and other circumstances related to the goods and services being valued[7]. The CVM is a survey-based method used to estimate the economic value of non-market goods. It does this by setting up a hypothetical market in which people are asked to state monetary bids for various goods based on the information provided to them. The underlying assumption is that "people are able to translate a wide range of environmental criteria into a single monetary amount representing the total value to them of a particular resource, and the more they value it the more they will be willing to pay for it. As such, contingent valuation is theoretically able to measure both use and non-use values of a resource" (White and Lovett, 1999: 2). Also, Imber *et al.* (1993) state that "[the] use of CVM relies on the assumption that responses to hypothetical markets reflect the choices and the values that would be revealed if an actual market existed" (p: 8).

[7] Further discussion in this regard is provided later in this chapter.

The CVM was first proposed by Ciriacy-Wantrup in 1947, who recognized that some aspects of soil erosion (e.g. clogging of shared irrigation channels) had the attributes of a negative externality that was not borne as a cost by the individual farmer (Ciriacy-Wantrup, 1947). He did not actually apply any CVM. The first application of CVM was done by Rob Davis (1963) in his Harvard PhD dissertation on the economic value of recreation in the Maine woods for estimating hunting and recreation values (Kopp *et al.,* 1997). In his study, Davis compared the results of the CVM against the travel cost method for the same area and found that the two methods arrived at remarkably similar valuations. The CVM studies became popular following the publication of a highly influential paper by John Krutilla (1967) that endorsed the 'real' nature of existence and other passive-use values. Since then, hundreds of studies have applied CVM[8]. As a result of these efforts, CVM has advanced and matured to such a point that "it is now rapidly moving from being esoteric and idiosyncratic economic instrument to the status of a useful and necessary informative tool" (Santagata and Signorello, 1998: 2).

The CVM has become a particularly popular tool to assess the value of non-market goods and services after the landmark endorsement by the National Oceanic and Atmospheric Administration (NOAA) Panel following the Exxon Valdez oil spill in the Gulf of Alaska in 1989[9] that "…CV [contingent valuation] studies can provide estimates reliable enough to be the starting point of a judicial process of damage assessment including lost passive use [non-use] values" (Arrow *et al.,* 1993: 4610).

Although it originated in the western world (particularly in the USA), this technique is now equally used in developing and transition economies (Georgiou *et al.*, 1997; Whittington, 1998 and Mourato, 1998). CVM studies are also growing rapidly in developing countries, especially as part of the assessment of externally funded environmental projects (Ardila *et al.,* 1998 and Russell *et al.,* 2001).

The CVM is being widely applied for estimating non-use values or components of TEV (Mitchell and Carson, 1989 and USACE, 1996). Non-use values cannot be measured by other methods since they are not based on market transactions. Indeed, the contingent valuation method is considered to be the only available method for

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[8] A bibliography lists over 1400 studies (books, articles, reports etc) based on the application of the contingent valuation method (Carson *et al.*, 1995b).

[9] Details about the NOAA Panel are discussed in the next chapter, and further details of the Exxon Valdez oil spill can be seen in Carson *et al.* (1992) and Carson *et al.* (1995a).

measuring non-use values (Freeman, 1993; Carson *et al.,* 1995b; Bishop *et al.,* 1997 and Georgiou *et al.*, 1997). As discussed earlier, not only components of non-use value, but also some components of use value do not have established markets in the study area. Over the years, the CVM has been used to estimate both use and non-use values, that means, all the components together or in other words, a combination of components of the TEV can be measured through CVM (Carson *et al.,* 1992; Diamond and Hausman, 1993; Hoevenagel, 1994; Bateman and Langford, 1997; Berrens *et al.,* 2000, Russell *et al.,* 2001 and Tyrväinen, 2001). As Carson *et al.* (1992) state that "[i]n many instances, valuation as package is more desirable than piece-wise valuation [component-wise of TEV] since such piece-wise valuation neglects the possibility that the value of one service is dependent upon the value of another" (footnote 8, p: 37). As the purpose is to estimate non-market benefits, the CVM would be the technique of choice and is used for this study as a package for the non-market components of TEV. The survey instrument, particularly the CV scenario, is designed keeping this in mind.

In a CV survey, respondents can be asked to specify either their WTP to secure a benefit, or their willingness to accept (WTA) compensation to forego a benefit or tolerate environmental degradation, continuous deterioration or lack of environmental improvement. To obtain a conservative benefit estimate and to maximize the legitimacy of the valuation problem to the respondent, a WTP question is used to estimate the non-market benefits of an environmental programme. Therefore, the household's WTP, rather than WTA, for environmental quality improvement estimated from the contingent valuation survey is the correct measure of welfare in this study. The choice of WTP or WTA scenario for a particular welfare change is crucial in the CVM. Theory shows that some differences should be expected in the sum stated according to whether a WTP or WTA scenario is adopted. In his seminal work, Willig (1976) shows that, for private market priced goods, this difference should be minimal. However, some (e.g Hanemann, 1991) claim a theoretical basis[10] for the very wide discrepancy between CVM measures of WTP and WTA for public, non-market and quantity-constrained goods. The NOAA Panel recommends WTP as a measure of welfare change[11].

10 Hanemann (1991) suggests that large empirical divergences between WTP and WTA depend on a substitution effect as well as income effect.

11 Features of the NOAA Panel recommendations are discussed in the next chapter.

Although the CVM is appreciated for its unique ability to measure non-use values and TEV, there is a large body of literature criticising the method both related to the practical implementation (e.g. survey design) and problems inherent in the method itself. The substance of most of the criticism directed at CV is that it is based on a hypothetical market which in reality is non-existent (see, for example, Cummings and Harrison, 1994). The critics argue that the answers obtained in hypothetical situations are subject to a variety of biases which make them invalid as valuation of the good in question (see, for example, Diamond and Hausman, 1994 and Cummings *et al.*, 1995). However, both theoretical and empirical works have progressed to such an extent that it is not only possible to determine these biases, it is also possible to undertake remedial measures to overcome these biases (Mitchell and Carson, 1989; Hanemann, 1994 and Smith, 1994). As Angelsen *et al.* (1994) state, "[t]he conclusion is *not* that the CV [contingent valuation] method should be rejected on the basis of the long list of potential biases. One should be aware of the difficulties involved, and try to avoid these pitfalls through all the stages of design, implementation and analysis" (p: 49, emphasis original). The use of CV has also been endorsed by the eminent members of a specially convened 'blue-ribbon' panel of experts for the US National Oceanic and Atmospheric Administration (Arrow et al., 1993), and the UK Department of the Environment (Bateman and Langford, 1997). The CVM is also recommended for use by Federal agencies in the USA (e.g. US Army Corps of Engineers, US Fish and Wildlife Service and US Water Resources Council) and for valuing natural resource damages (e.g. US Department of Interior) (Bishop *et al.,* 1995 and Ekstrand and Loomis, 1998). It has also been widely used by international aid agencies such as the World Bank (WB), Asian Development Bank (ADB) and Inter-American Development Bank (IADB), and both by bilateral and multilateral donor organizations such as Overseas Development Administration (ODA) and Organization for Economic Co-operation and Development (OECD).

Despite its many criticisms and limitations, the CVM has received tacit recognition as a valid measure of both use and non-use values. Balancing both the advantages and disadvantages of the CVM, Russell (2001) states that "[t]he survival and growth of CV [contingent valuation] in spite of the attack on its validity probably have more to do with its advantages in being able to address almost any policy question asked and being able to measure total economic value (TEV) than in the effectiveness of the response to these attacks" (p: 328). Most importantly, careful survey design can eliminate many of the limitations and control biases and thus can provide valid estimates. Seen in this light, the CVM can make an important contribution to measuring environmental benefits in addressing environmental problems and aiding policy making both in developed and developing countries. The protocol for a carefully designed CV survey is discussed in the next chapter together with the survey design procedure for this study.

3.2.3 Willingness-to-Contribute: A New Approach in Economic Valuation of Non-market Goods and Services

The theoretical assumption underlying the CVM is that people have well-defined and stable preferences for environmental goods which can be elicited through carefully designed and administered surveys (USACE, 1996). In the CV survey, money is used as a unit of account for eliciting peoples' preference. Georgiou *et al.* (1997) state that the use of money as the measuring rod permits the comparison for various policy decision-making purposes. Also, for the purpose of comparing, it is a conventional practice to use dollar value along with the local currency of the study area. The question is whether one can always use a money yardstick to value environmental/non-market goods. How can the economic valuation capture the situation where considerable portions of the economic activities are not monetized? These issues will be discussed later in this section.

A conventional contingent valuation survey asks respondents about their direct monetary contribution. The different variants of CV can be distinguished on the basis of exactly how they elicit the willingness to pay. Asking respondent a question may take many forms, such as:

- **Dichotomous Choice Question:** A dichotomous choice (DC) elicitation is simply a "take-it-or-leave-it" approach where respondents are presented with a dollar amount for the price of a hypothetical permit to which they respond either "yes", if they are willing to pay the amount or "no", if they are not willing to pay (Johnson *et al.,* 1990). The DC questions are variously referred to as "take-it-or-leave-it", "closed-ended" or "referendum" approaches. The referendum format is a DC question with the payment vehicle posed as a referendum vote.

- **Open-ended Question:** Respondents are asked for their maximum WTP for the good that is being valued with no value being suggested to them (Angelsen et al., 1994).

- **Bidding Game:** Respondents are asked whether they are willing to pay a specified amount. If respondents answer affirmatively, then the amount is incrementally increased. This process continues until a no-answer is obtained (Bateman *et al.,* 1995).

- **Payment Card:** A range of values is presented on a card from which respondents are asked to choose an amount that best represents their maximum willingness to pay (Angelsen *et al.,* 1994 and Rowe *et al.,* 1996). Respondents may also be shown the typical expenditure for a given income group on other publicly provided services (Boardman *et al.,* 1996).

The advantages and disadvantages of each of the question formats and their applicability in the selected case study in Bangladesh are discussed in the next chapter while describing the survey design.

Regardless of the question format, the CVM involves asking respondents hypothetical questions about their monetary valuation of a situation. The unit of account of value is "money metric" and in most cases this is converted into dollar terms. Dollar value is preferred as "*dollar expressions of benefits are meaningful* in that they can be interpreted unambiguously and consistently by different users of a benefits [sic] assessment" (Cox, 1986: 98, emphasis original).

However, the conventional approach of asking valuation questions does not take into account the local context in developing countries where many of the activities are non-monetized, and also many of the transactions are conducted in non-monetary ways. For instance, despite the massive commercialization of the economy in recent years, many activities are still non-monetized in Bangladesh. In many parts of the country, labour as a resource is only partially measured in monetary units (money metrics). In many cases, only part of the labour wage is paid in money metric, while either food or rice/grain is provided as payment for the remainder. In many instances, donations/contributions for philanthropic activities (e.g. establishment of school, religious institution/congregation and social club) are collected in the form of grain/rice or materials (e.g. cows, goats, chickens or bamboo).

The questions asked in a CV survey are based on the assumption that all respondents have equal ability to pay. However, residents who are more affluent have more discretionary real income to potentially allocate to environmental improvements as well as other things that they value. Income inequality among residents is more acute in developing countries than in developed. For instance, the share of income accruing to the bottom 40 percent and top 5 percent of the households is 18.44 percent and 18.85 percent respectively in Bangladesh (PC, 1998). By comparison, data from the Australian Bureau of Statistics on percentage share of gross weekly income indicates that the lowest 40 percent and the top 5 percent respectively share 13.2 and 11.87 percent of total income[12].

Although the questions posed to respondents imply equal sharing of contribution among all respondents, it is reasonable to assume that residents would give some weight to what they perceive to be their actual contribution as well as their income when providing an answer to valuation questions. Studies show that people with comparatively high level of disposable income are more willing to contribute financially to environmental improvements than poorer people. A statistically significant relationship between respondents' willingness to pay and their income is found in many studies (see, for instance, Carson and Mitchell, 1993; Arimah, 1996 and Lauria *et al.,* 1999). Should this be interpreted as evidence that the affluent people care more for their local environment than less affluent people? Methods that rely on the conventional willingness to pay approach possibly overlook the potential contributions and concerns of people with low incomes. Furthermore, individual incomes for many respondents are inadequate to meet basic needs. More than 22 percent of the adult population are not doing any work and about 26 percent are involved with unpaid household works in the study area (BBS, 1993). For those respondents, it does not make sense to express willingness-to-pay from their "disposable" income. These important aspects/ dimensions are ignored in framing conventional CV questions.

In order to capture this aspect of the respondents' preference in the context of developing countries in particular, the conventional contingent valuation technique is extended by adding a new measurement unit, i.e. time, along with the conventional money unit of measurement when asking the valuation questions. In this format, respondents are asked, irrespectively of their willingness to contribute money (WTC_M), whether or not they would be willing to contribute in terms of time. This non-monetary contribution, that is, willingness to contribute time (WTC_T), is very important in the context of developing market economies. This kind of non-monetary contribution has enormous significance and social acceptance in the context of value judgement in a country like Bangladesh. It has particular significance in the context of low disposable

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12 Estimates based on the available data (http://www.ecoteacher.asn.au/unemploy/a28.htm, access on 23.4.03).

family income, high rate of unemployment and respondents' unfamiliarity with the preference elicitation process in a hypothetical market.

Therefore, in an extended contingent valuation (ECV) survey, in addition to a conventional willingness to pay (WTP) questions, new questions in the form of respondents' willingness to contribute time (WTC_T) should be asked. These two types of questions – WTC_M and WTC_T – together represent the respondents' total willingness to contribute (TWTC) to a proposed environmental programme. Thus,

total willingness to contribute (TWTC) = willingness to contribute money (WTC_M) +
+ willingness to contribute time (WTC_T)

or, $TWTC = WTC_M + WTC_T$. (3.3)

Conventionally, the concept "willingness to pay"' is used to refer to the respondents' preference of direct payment for an improvement. In this study, this concept is referred to as "willingness to contribute money or WTC_M". Measuring the willingness to contribute time (i.e. WTC_T) and hence, the total willingness to contribute (i.e. TWTC) is not just another way of answering the valuation question, rather it is another approach to valuing the environment. This approach estimates the respondents' preference for environmental goods better than the conventional method. An application of this new approach will be examined in the case of the BRCP throughout the next chapters. The distinctive features of the new approach of the CV study are traceable in the ways the scenario is set up, the survey executed, the data analyzed, and policy implications derived for the selected case.

3.2.4 Aggregation of the Total Value

The purpose of the contingent valuation method is to aggregate individual values generated through a survey to obtain the total non-market benefits of the goods and services being valued for the relevant population. The CV survey is used to elicit values for non-market goods which could be interpreted as direct measures of the welfare change associated with environmental improvements (USACE, 1996). Such a direct valuation question produces a maximum WTC estimate for each survey respondent in the sample survey. In the case of this study, the CV survey yields the individual's WTC for the proposed programme. The WTC value represents marginal benefits or stated preferences of the individual respondent. The question now is: how is it possible to get an aggregate WTC in terms of a demand curve and the TWCT for the BRCP? One way to derive an aggregate measure of welfare change for the entire population from which the survey sample is drawn is to calculate the sample mean of the WTC estimates, and multiply it by total population (Freeman, 1993)[13].

The ECV survey is able to provide the number of individuals who are willing to contribute at least a particular amount of money or their effort in terms of time for the proposed programme. Therefore, one can ascertain the aggregation of total non-market benefits from the respondents' agreement to contribute to the programme, using simple arithmetics and total benefit for the whole of the target population, through extrapolation. The aggregate or total willingness to contribute curve is thus the vertical summation of individual values (both money and time) over the relevant population.

In the TEV framework, the total benefit is the sum of both market and non-market benefits. In the case of a market good, both market price (P) and quantity (Q) purchased are directly observable in the marketplace, and thus, multiplied together, as PQ, these yield the total expenditure (cost) for the good in that market at a given time. However, estimates of non-market benefits are difficult as already discussed.

In the neo-classical welfare economics, the concept of consumer surplus is used to analyze the welfare impact of a price change, a quantity change or a change in the provision of some public goods. Consumer surplus (CS) is a monetary measure of the maximum gain that an individual can obtain from a good at a given market price. It is often defined in the context of markets for private goods, where individuals pay a monetary price in return for a good or service that provides value to them. Hicksian demand curves, named after Sir John Hicks, or compensated demand curves can be used to derive the consumer surplus. The measurement of willingness to pay is given as (Abelson, 1996):

$$\text{WTP} = \text{P} + \text{CS} \tag{3.4}$$

Although estimating prices of marketed goods and services can be fairly straightforward, consumer surplus is not directly observable in a market. A more sophisticated estimation approach is thus required (Fuguitt and Wilcox, 1999). This is even more complicated in the case of non-market goods, as neither the market price nor the consumer surplus is observable in the market place. Nevertheless, in the case of

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13 An alternative way, as Freeman (1993) states, would involve estimating a valuation function by regressing the WTP responses against income or other socio-economic characteristics of the respondents. The resulting parameter estimates could then be combined with data on the socio-economic characteristics of representative groups within the population to produce an aggregate measure of welfare change.

non-market goods, despite the non-specificity of the exact dividing line between use and non-use values (as already discussed), the estimation of TWTC is a straightforward approach by applying the non-market valuation technique, outlined above. The measurement of TWTC does not require separate estimation of consumer expenditure and consumer surplus. In this case, all benefits estimated through a CV survey are consumer surpluses (Abelson, 1996), that means, individuals' WTC value will be equal to their consumer surplus.

The total value or benefit (B) of the public intervention is the sum of the benefits to all individuals who are willing to contribute for environmental improvement (both WTC_M and WTC_T) and the value derived from market transactions of goods and services generated by the proposed action. Thus, the total benefits (B) can be expressed in the form of the following equation:

$$B = \sum_{i=1}^{m} P_i Q_i + \sum_{j=1}^{n} WTC_{Mj} + \sum_{k=1}^{o} WTC_{Tk} \qquad (3.5)$$

where

i = individual market benefit;

j = individual WTC_M;

k = individual WTC_T;

m = total number of market benefits;

n = total number of individuals WCT_M;

o = total number of individuals WCT_T;

P_i = price of the market benefit i;

Q_i = quantity of the market benefit i;

WTC_{Mj} = amount of money individual j is willing to contribute; and

WTC_{Tk} = amount of time individual k is willing to contribute.

The equation (3.5) can be interpreted as an estimate of the gross benefits arising from environmental improvement measures including the application of the modified approach of the CV survey. This model/specification will be used in this study to measure the total benefit of the environmental improvement programme.

3.3 Theoretical Framework for the Integrated Decision Making

This section begins with a discussion of the conceptual basis of the decision-making process – the cost-benefit analysis. This is followed by issues of shadow pricing and the choice of discount rate. It also discusses the theoretical underpinning of cost-benefit analysis including decision criteria.

3.3.1 Framework for Integrating the Environment into Decision Making

Policy decision-making with regard to public sector investment implies examining the worthiness of an intervention (investment). This intervention can take many forms, such as policy formulation, introducing regulation, undertaking a project or programme. This study analyzes a programme, but what is applicable for a programme is also applicable for a project, and these two terms are used interchangeably. An integration of environmental dimensions into policy decision making means incorporating all costs and benefits in the decision-making calculus, particularly, environmental or non-market benefits which do not pass through any market and thus do not bear any "value" in the conventional approach. Therefore, the policy decision-making procedure is in essence an investment decision-making process in the context of this study. While there are many techniques and approaches for appraising the projects and programmes available, the focus of this study is restricted to, what is termed as, cost-benefit analysis (CBA).

Cost-benefit analysis requires a general framework within which costs and benefits are incorporated and assessed from society's perspective. It basically provides information to decision makers to decide whether allocation of resources for a particular project is economically efficient[14]. As Nas (1996) states about the CBA, "[n]ot only it is a framework that draws on the fundamental principles of welfare economics, but it is also a way of thinking, because it provides guidelines for public policy makers in their search for a resource allocation that would be best suited to society's efficiency and equity objectives" (p: 4). Therefore, the use of such a framework reflects two factors. First, decision making, which considers that any investment in relation to a project or programme will involve an assessment of the costs and benefits of such a decision. Second, decisions made by society involving the allocation of environmental resources (non-market goods and services) will necessarily imply economic valuation.

[14] There are numerous texts dealing with the theory and practice of the standard CBA, such as Pearce (1983), Mishan (1988), Hanley and Spash (1993), Perkins (1994), Boardman *et al*. (1996) and Brent (1996). Bilateral aid agencies and multilateral development banks have developed their own guidelines for project and policy analysis (e.g. UNIDO, 1972; ODA, 1988; OECD, 1995; ADB, 1997; Belli *et al*., 1996 and Ward *et al.,* 1997 for the WB; and Russell *et al*., 2001 for the IADB).

The CBA is a straightforward appraisal technique if all the costs and benefits of the project are identified and valued. It becomes complicated when either some costs or benefits are not quantified or valued. The costs of implementing environmental programmes can be a private good in the sense that the information is available in the market. Therefore, the observed prices can be used in the CBA. On the other hand, there is no information either from conventional markets or related markets for some benefits, particularly non-market benefits. The conceptual and theoretical issues regarding valuing the non-market goods described above will generate a value for the society as a whole through an ECV survey. Other benefits which have market value can be monetized using market data.

Through rounding these, one can proceed towards formulating decision criteria. This means both costs and benefits can be used together to take an integrated decision about whether benefits outweigh costs and such an undertaking (e.g. environmental improvement programme) from the point of view of society as a whole is economically efficient (i.e. is capable of generating surplus welfare gain for the society). Therefore, a CBA conducted in such a way is an extension of the conventional approach and includes non-market benefits derived through asking respondents of the ECV survey about their WTC_M and WTC_T. This version of the CBA is referred to in this study as the extended cost-benefit analysis (ECBA).

The benefits and costs that are included in a CBA are incremental; they arise with the intervention, compared to the without the intervention situation. This "without-intervention scenario" is called a baseline scenario and it has been detailed in *Chapter Two*. In the "without-intervention scenario", it is assumed that present conditions and practices will continue unabated and to some extent the current situation will deteriorate. The "with-intervention scenario" associated with the proposed cleanup programme is discussed in Section 3.4.2.

3.3.2 Theoretical Underpinning of the Cost-Benefit Analysis[15]

If a government intervenes by undertaking an action in order to improve the overall environmental quality in a locality, to what extent will surplus values be generated for society as a whole? Following Fuguitt and Wilcox (1999: 45), this can be divided into two questions:

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[15] This section is partially drawn from Fuguitt and Wilcox (1999).

- How much do different members of the society value the intervention? That means, how much would each member be willing to contribute for the proposed programme, or, in other words, what *social benefits* (or utility) will society receive from such a programme; and
- How much does society actually pay for the programme? That means, what are the *social costs* in terms of resources used to provide the programme.

By answering these two questions, the difference between social benefits and costs can be calculated to find the surplus value generated by the intervention. This surplus value is called the *net benefit* to society, where

$$\text{net benefit} = \text{total benefits} - \text{total costs}. \quad (3.6)$$

All decision criteria in regard to cost-benefit analysis are based on this notion, i.e. the need to *adopt policies that have positive net benefits*. If the net benefit is positive, then the proposed project/programme is able to achieve allocative efficiency. At the heart of CBA is the concept of allocative efficiency. This is referred to as Pareto efficiency[16] or Pareto optimality, after an early Italian economist, Vilfredo Pareto. As Boardman *et al.* (1996) state, cost-benefit analysis "can be thought of as providing a protocol for measuring *allocative efficiency"* (p: 28, emphasis original).

By choosing projects/programmes with positive net benefits, society as a whole can maximize aggregate wealth through satisfying the Kaldor-Hicks criterion which states that "a policy should be adopted if and only if those who will gain *could* fully compensate those who will lose and still be better off (Boardman *et al.,* 1996: 32, emphasis original). The Kaldor-Hicks criterion also provides the basis for the potential Pareto efficiency rule: "[a]dopt only policies that have positive net benefits. As long as net benefits are positive, it is at least possible that losers could be compensated so that the policy *potentially* could be Pareto improving" (*ibid,* p: 32, emphasis original). Therefore, a net positive benefit indicates that those gaining from a project/programme could, at least hypothetically, compensate those losing from it. Thus, everyone could ultimately gain from a project that generates a positive net benefit. That is, a project is socially desirable if it can result in a potential Pareto improvement (PPI). The

16 Pareto efficiency refers to a situation when improvement of one indicator does not lead to deterioration of any of the remaining indicators.

fundamental assumptions behind the PPI criterion are that losses are compensatable[17], and that gains and losses are comparable with each other (Hanley *et al.,* 2001). By measuring the gains as the money value of benefits and costs as the money value of losses, the PPI criterion can be translated into a single number, namely the money value of total net benefits of a project/programme. This PPI criterion is the basis of the cost-benefit analysis. It requires that the total of all benefits exceeds the total of all costs so that the 'winners' could be taxed to compensate the 'losers'.

Once all benefits and costs are expressed in a common yardstick (i.e. money), these can be incorporated into a decision-making rule, namely the cost-benefit analysis, which will reflect the perspective of the society as a whole. The CBA is used as a tool for policy and project analysis in order to improve the quality of government and agency decision making. Although CBA is the most comprehensive form of economic analysis and it has been used as an aid to decision making in many different areas of economic and social policy in the public sector, it is not beyond criticism. Some of the relevant criticisms, both in relation to theory and application and specific to environmental issues are reviewed below.

It has been argued that the use of money yardstick for measuring costs and benefits lends a false accuracy to the result of a cost-benefit analysis. It can be summarized that "[a]nalyses are criticised for conveying a false sense of accuracy by *including* quantified values for non-monetary effects such as the number of human lives expected to be saved… Alternatively, analyses are criticised for excluding intangible effects" (ADOF, 1991: 82, emphasis original).

Also, many have disputed "the fundamental utilitarian assumptions of CBA that the sum of individual utilities should be maximized and that it is possible to trade off utility gains for some against utility losses for others" (Boardman *et al.*, 1996: 2). The CBA is also criticised for such practical issues as "whether certain given impacts are costs or benefits, what those impacts will be over time, how to monetize (attach a dollar value to them), and how to make trade-offs between present and the future" (*ibid*).

The choice of discount rate in CBA is a controversial issue. Environmentalists argue against discounting in general and against a high discount rate in particular because they believe high discount rates are associated with environmental degradation (Goodin, 1982). Markandya and Pearce (1994) argue that the debate concerning the rationale for

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17 Often this is a very difficult thing, but certain things can be negotiated.

discounting raises "issues of concern with respect to the uses of rates of interest which reflect pure time preference, but it does not provide a case for rejecting pure time preference completely" (p: 39).

Despite all these problems both general and specific to its application to environmental issues, many argue for the use of CBA as "a way of systematically organizing arguments about whether a project or policy should go ahead or be stopped" (Hanley and Spash, 1993: 269). A properly conducted CBA can generate enormous information about a project/programme, such as cost and benefit streams, beneficiaries, relative merits of different components of the project, affected people and income and distributional effects which can aid resource allocation decisions. Also, the development and application of valuation techniques, particularly ECVM, make it possible to incorporate many of the 'intangible effects', such as non-use benefits, into the CBA. That is why CBA has been accepted as the main procedure for project appraisal by many domestic governments and international aid organizations since the 1970s (see, for example, Angelsen *et al.*, 1994 and Russell *et al.,* 2001). In this study, an extended CBA is used integrating non-market benefits through applying an ECV survey.

3.3.3 Issues of Shadow Pricing and the Choice of Discount Rate

Before proceeding towards decision criteria for the CBA, issues of shadow price and discount rate need to be discussed. These are important for constructing a cash-flow and to conduct a cost-benefit analysis.

Market prices usually represent economic values, but in certain cases they become unable to do so. In the absence of competitive market conditions, such as policy distortions in the form of taxes, subsidies, quotas or overvalued exchange rates, particularly in the context of developing countries, market prices are likely to misrepresent true scarcity values. Although economic valuation of market goods and services is relatively straightforward, in the absence of competitive market conditions, valuation becomes more complex because one has to predict what prices would have prevailed in the absence of these distortions. This process is known as *shadow pricing*.

Shadow prices can be expressed/calculated in two ways. Either they can be expressed directly in *world price numeraire*[18], when all economic prices are expressed

18 This approach is also referred to as the Little and Mirrless approach or the World Bank approach. Little and Mirrless (1974) developed this approach for the Organization for Economic Co-operation and Development (OECD)

in their equivalent world price levels or in *domestic price numeraire*[19], when all economic prices are expressed in their equivalent domestic price level values (ADB, 1999b). Both approaches are very similar in spirit, and in most circumstances yield identical results (Chowdhury and Kirkpatrick, 1994). Belli *et al.* (1997) state that "[t]he choice of currency and price level is largely a matter of convenience that will have no impact on relative prices and on the decision to accept or reject a project" (p: 11). In general, where domestic market prices differ from border prices for similar goods, the average difference defines the relation between the world price and domestic price numeraires. The use of a different numeraire to express opportunity costs will not affect the relative value of project outputs and inputs (Curry and Weiss, 1993).

Shadow prices will be calculated on the basis of world or border price numeraire in this study. Therefore, the numeraire and price level in which to conduct the economic analysis are the domestic currency and border price level. Under this approach, the main price adjustments include (i) using border prices for all tradeable goods and services and converting into domestic currency at the prevailing market or official exchange rate, and (ii) converting domestic prices of non-tradable goods and services into their border-price equivalents by means of adjusting through the 'conversion factor'[20] (Belli et al., 1997; ADB, 1999a and ADB, 1999b). Where the item-specific conversion factor could not be estimated, the conversion of the domestic price of an item into its border price can be done using a standard conversion factor.

The shadow price (SP) as given by Abelson (1996) is:

$$SP = MP \times CF \tag{3.7}$$

where MP stands for market price and CF for conversion factor.

The conversion factor is the ratio between shadow and market prices for a project item. When the appropriate information is available, the mechanics of revaluing a project resource flow are quite straightforward – for each item a conversion factor is applied to transform the project components from market to shadow prices.

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which was subsequently extended by the World Bank (Squire and van der Tak, 1975) and the UK Overseas Development Administration (ODA, 1988).

19 This approach, developed by Dasgupta, Marglin and Sen (1972) for the UNIDO, is known as the UNIDO approach.

20 A conversion factor is also sometimes called an accounting price or simply an accounting ratio (Curry and Weiss, 1993).

Shadow prices need to be calculated for this study as significant price distortions still exist in the economy of Bangladesh despite the massive liberalization of fiscal policy and opening up of the economy since the mid-1980s (Alam, 1998). However, it is beyond the scope of this study to calculate conversion factors for the inputs (cost flow) of the proposed cleanup programme. For the purpose of appraisal, conversion factors for major inputs are calculated by the Bangladesh Planning Commission and are used in Bangladesh. These factors will be applied for the CBA in *Chapter Six*.

In order to reflect costs from the viewpoint of the economy as a whole rather than from the viewpoint of the individual entity, some items of the financial costs are to be excluded in estimating the economic costs while some are to be included. Taxes, duties, and subsidies are called transfer payments because "they transfer command over resources from one party (taxpayers and subsidy receivers) to another (government, the tax receivers and subsidy givers) without reducing or increasing the amount of real resources available to the economy as a whole" (ADB, 1999b: 143). Therefore, all transfer payments need to be excluded from economic costs (project resources).

Many recommend calculating shadow prices at the project location rather than the border itself and hence to calculate border parity price, which include adjustments for the handling and transport costs in addition to transfer payments between the project location and the border (Curry and Weiss, 1993). This adjustment has been reflected in the estimation of shadow prices in *Chapter Six*.

Once all relevant benefit and cost flows that can be expressed in monetary units are estimated, they are converted into 'present value' (PV) by discounting. Costs and benefits often occur at various points in time. To evaluate such an intertemporal mixture of costs and benefits, the standard approach is to convert future costs (or benefits) into equivalent current costs (or benefits), using a *discount factor*. Discounting is necessary because of the existence of a market interest rate and thus all future costs and benefits flows need to be converted into present value to make them comparable with each other (Hanley, 2000). The present value of a cost or benefit (X) received in time *t* with a discount rate of *r* is calculated as follows (Hanley and Spash, 1993) :

$$PV = X_t\,[(1+r)^{-t}\,] \tag{3.8}$$

The expression in the square brackets in equation (3.8) is known as a *discount factor*. Discount factors have the property that they always lie between 0 and +1. The choice of a discount rate is a contentious issue. There is some controversy over what the appropriate value of the discount factor is, particularly when used for environmental decision making. Some economists have proposed using very low discount rates (e.g. Cline, 1993), while others argue that "a lower rate could also make investment project with negative environmental impacts more acceptable" (Angelsen, 1991: 1). Kolstad (2000) states that "[t]he simplest answer is that the discount factors are market determined, based on how consumers and producers trade off the present with the future" (p: 72). It is beyond the scope of this study to determine what constitutes a theoretically acceptable discount rate or how the 'correct' rate should be estimated in practice. In many countries, government agencies calculate and declare a discount rate to be used for project appraisal. In the case of Bangladesh, the discount rate for use in CBA is mandated by the government authority (i.e. Planning Commission) and is 15 percent (nominal). This rate of discount will be applied for the appraisal of the cleanup programme in *Chapter Six*.

Another issue to consider is whether to use a nominal (current) or real (constant) discount rate. In programme appraisal, care is taken to ensure that the units of measure of costs and benefits are consistent with the units of measure of the discount rate. Boardman *et al.* (1996) state that "[i]f benefits and costs are measured in nominal dollars, then the analysts should use a nominal discount rate; if benefits and costs are measured in real dollars, then the analysts should use a real discount rate. Both methods result in the same answer" (p: 126). An inflation-adjusted real discount rate is usually used in the CBA. The real rate of discount is calculated as (Curry and Weiss, 1993):

$$\text{Real rate of discount} = (1 + i)/(1 + p) \tag{3.9}$$

where i is the nominal rate and p is the annual average rate of price increase.

Evaluating economic efficiency is the primary objective of most CBA, and in this study the interest is not in the effects of a project on income distribution. Efficiency is measured without regard to whom the benefits and costs accrue and irrespective of whether society considers the prevailing distribution of income to be desirable. As the distributional issue is not of concern, the distribution of costs and benefits is not considered within the framework of ECBA[21].

3.3.4 Decision Criteria in Cost-Benefit Analysis

[21] Although in some particular situations, the distributional issue could be very significant.

Once both the benefits and costs of a proposed public intervention are available, the question that arises is how can this information be used to assess the desirability of specific public investment. There are three criteria commonly employed within the framework of the CBA. These are net present value (NPV), internal rate of return (IRR) and benefit-cost ratio (BCR). These are elaborated below.

Net Present Value: The basic criterion for comparing the costs and benefits of a project relative to the baseline case is the net present value (NPV), which is the discounted value of all future costs and benefits. The NPV is defined as (Abelson, 1996):

$$NPV = \sum_{t=0}^{n} \frac{B_t - C_t}{(1+r)^t} \qquad (3.10)$$

Alternatively, separating benefits and costs:

$$NPV = \sum_{t=0}^{n} B_t (1+r)^{-t} - \sum_{t=0}^{n} C_t (1+r)^{-t} \qquad (3.11)$$

where B_t and C_t are the total benefits and costs in period t respectively, r is the discount rate, and n is the time horizon. The summation $\sum$ runs from t = 0, meaning the first year of the project to t = n, meaning the last year of the project. The expression in brackets is the discounted factor where the rate of discount is assumed to be the real rate of interest r in period n. In the above equation, benefits and costs are discounted relative to present benefits and costs in order to obtain their present values.

For a project to be accepted, the discounted value of its benefits should exceed the discounted value of its costs, i.e. NPV > 0. In other words, when there is only one potential project, the project can proceed if the net present value of social benefits is positive. Where there is more than one alternative to the status quo, the rule is slightly more complicated: select the project with the highest NPV. As Hanley and Spash (1993) state "this criterion [net present value] is firmly based on the Kaldor-Hicks principle of neo-classical welfare economics: under these conditions, any project passing the NPV test is deemed to be an improvement in social welfare" (p: 18). In such a case, the project can be said to represent an efficient shift in resource allocation, given the data used in the CBA.

Internal Rate of Return: The internal rate of return (IRR) is defined as the rate of return on an investment which will equate to the present value of benefits and costs. It is found by an iterative process and is equivalent to the discount rate (r) that satisfies the following relationship (Dixon *et al.,* 1996):

$$\sum_{t=0}^{n} \frac{B_t - C_t}{(1+IRR)^t} = 0 \qquad (3.12)$$

$$\text{or} \quad \sum_{t=0}^{n} B_t/(1+IRR)^t = \sum_{t=0}^{n} C_t/(1+IRR)^t \qquad (3.13)$$

The IRR is the discount rate that would result in a zero net present value for a project. The project is acceptable if IRR > *r*, which in most cases implies NPV > 0 (Young, 2001). However, the IRR is criticised as a flawed measure of resource allocation for two principal reasons: first, many projects can generate multiple IRRs from the same data set, so the analyst does not know which to select as the decision-making criteria; and second, the IRR is unreliable when comparing performance across many projects in a portfolio (Hanley, 2000).

Benefit-Cost Ratio: The benefit-cost ratio (BCR) is simply the ratio of discounted benefits to discounted costs. The BCR can be expressed as follows (Munasinghe, 1993):

$$BCR=\left[\sum_{t=0}^{n} B_t/(1+r)^t\right] / \left[\sum_{t=0}^{n} C_t/(1+r)^t\right] \qquad (3.14)$$

where all the symbols are as before. This ratio compares the discounted benefits to discounted costs. A project with a BCR greater than one has also a positive NPV, that is, if BCR > 1, then NPV > 0 and the project is acceptable.

Both BCR and IRR criteria have its strengths and weaknesses, but NPV is probably the most useful. However, “where resource statements are drawn up using the same information and assumptions, these three criteria yield the same decision for single projects” (Curry and Weiss, 1993: 45). Although it is presented here for the case of desirability of a single project, the decision criteria can also be used for choosing a project among alternative options.

These criteria can be used only as information and guidance, and need to be supported with other information as to the state of the environment and long term impact of the project on the economy. Cultural, ethical or moral issues are also more important than just the mere fact that *the quantified benefits of the action outweigh the costs*. This is particularly relevant for developing countries like Bangladesh.

Two examples from the recent policy debate in Bangladesh might be pertinent. First, the ready-made garments industry, the largest export earner in the economy, employs a lot of child labour in Bangladesh[22]. The opportunity cost of this labour is almost zero. If not employed in the garment industry, many would have engaged in pick-pocketing in the streets or in hooliganism. Although from the economic point of view it is acceptable, the concept of child labour may be morally unacceptable.

Second, against the backdrop of finding a significant amount of natural gas reserves under Bangladesh soil, a debate is currently taking place (as of mid-September, 2003) as to whether the country should export gas abroad[23]. The political regime in power supports exports, while the main opposition camp expresses its vow to oppose it at any cost. A couple of years back, the scenario was completely different. The current opposition party was at that time in power and was a strong proponent of exporting gas (see, for example, the Fifth Five Year Plan adopted during that regime). In contrast, the current government party (then in opposition) strongly opposed the idea of exporting gas. Now the country, through exporting gas explored by multinational companies, may receive a large positive payment and apparently incurs no costs. This may lead to a practically infinite IRR and a very high positive value of NPV. This example helps illustrate both the weakness of using the decision criteria and the mistakes that may be made if ‘other information’, such as social, long term economic impacts and the

22 Due to the extreme poverty of parents, social backwardness, lack of adequate schooling facilities and so on, many of these children cannot go to school.

23 The country’s energy resources consist of traditional fuels such as fuelwood, crop residuals and animal dung (55 percent), natural gas (24 percent), imported oil and coal (19 percent) and hydro-electricity (2 percent) (PC, 1998). The current potential gas reserve has been estimated at about 24.75 trilion cubic feet (TCF) of which 15.51 TCF is considered as commercially recoverable and as of December, 2000, cumulative exploration is 4.08 TCF and net recoverable reserve is 11.42 TCF (MOF, 2001). Less than five percent of the households are currently covered by the gas supply network. The Fifth Five Year Plan (1998-2002) states that “[w]ith the projected demand and known recoverable resources of gas, the country will start facing gas shortage after 2010 if no gas fields are discovered” (PC, 1998: 361). Although the country has a reputed public sector company (Petrobangla) capable of exploration, production and delivery of gas, the authorities seem to be more interested in inviting foreign multinational companies. The contract signed with the multinational companies for gas exploration is highly confidential and in many cases the terms and conditions favour them. For instance, in 1997, during a drilling in Magurchara, a well was blown up and a vast area of land (rich with natural resources) including many residents’ houses was destroyed. No compensation has been paid as yet as no such clause was included in the contract.

opportunity cost of depriving a country's own people from providing the gas, is left out of the decision-making process.

Because of such factors, it may be necessary to rely on other participatory and political processes, and also to take into consideration ethical, moral and cultural issues to make a final judgement about a proposed action. Seen in this context, the CBA can make an important contribution to these judgements providing the necessary information in a common yardstick for the policy makers.

3.4 Specifying Contingent Market for the Study

This section reviews valuation studies on environmental improvement with regard to river cleanups, describes the CV scenario for environmental improvements and defines the benefits of the BRCP which need to be valued for the study.

3.4.1 Valuation Studies of River Cleanups

A number of studies have so far applied CVM to investigate a range of water quality issues, focusing on residents' WTP for improvement in water quality, although only a few were concerned with river water quality in particular. Most importantly, very few of these are in a developing country context. As context matters significantly, what is applicable for developed economies may not be applicable for developing economies. For instance, it is comparatively easy to impose regulatory measures (such as tradable permits to reduce pollution at source) in developed countries. Whilst it can be applied in numerous ways to a plethora of situations, the focus in this section's review is on the application of the CVM in relation to the cleanup of rivers. The purpose is to provide a description of the valuation techniques applied in the case of river cleanup activities and to identify gaps in the existing body of knowledge with regard to the application of CVM and designing of a survey procedure, estimating benefits and designing of cleanup activities. The reviewed literature includes books, journal articles and published reports. In some cases, these documents contain inadequate information, particularly on survey design procedures and detailed design of cleanup activities, which restricted the review.

A number of different terminologies have been applied to describe a variety of interventions to improve the river ecosystems, such as 'cleanup programme' (Markandya and Murty, 2000), 'river restoration' (Tunstall *et al.,* 1999), and 'water quality improvement' (Harris, 1984; Green and Tunstall, 1991; Carson and Mitchell, 1993 and Barton, 1998). In this study, the term 'cleanup programme' has been adopted in order to take an integrated and holistic view of the problem.

Harris (1984) applies the CVM to determine the economic worth of a water pollution control programme in the Waikato Basin of New Zealand. The benefit of water pollution control is perceived as a sum of both 'market related' impacts and 'non-market' impacts. Non-market benefits include recreational benefits, aesthetic and option, existence and bequest values. The study reveals that the residents of the Waikato Basin would be prepared to pay approximately $ 3.7 million per year for the defined water quality improvement (approximately $16 per person annually). However, the study suffers from a starting point bias[24] as WTP values are measured by means of a bidding game.

Desvousges *et al.* (1987) conducted a CV survey to elicit option price bids for water quality changes of the Monongahela River in Pennsylvania. The survey was conducted among 393 households living in five counties on the Pennsylvania side of the river. The three water quality levels[25] to which individuals were asked to respond were (i) avoiding a decrease in water quality from boatable to unsuitable for any water-related activity; (ii) raising the water quality from boatable to a fishable level; and (iii) raising the water quality from fishable to a swimmable level. The sample was divided into four groups, and each was subjected to an alternative question format. The four alternative formats were iterative bidding with a $25 starting point, iterative bidding with a $125 starting point, direct (open-ended) question without a payment card and direct question with a payment card. Desvousges *et al.* conclude their study with two main observations: (i) the question format seems to influence the survey outcome; the bidding game with a $125 starting point and direct questions with payment cards led to higher prices than did the other two formats; and (ii) the CVM appeared to perform reasonably well in the Monongahela River case. The research confirms the view that "contingent valuation surveys seem capable of providing order-of-magnitude estimates of the benefits realized from enhancing one or more aspects of environmental quality" (Desvousges *et al.,* 1987: 265).

Sanders *et al.* (1990) use total value framework to estimate benefits of protecting rivers in the Rocky Mountain of Colorado, USA. River protection is defined as "no further construction of dams, reservoirs, water diversions, and other development

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24 Starting point bias refers to the bias associated with the initial amount quoted in the valuation question. Detail description is provided in the next chapter while discussing potential sources of bias and their remedial measures.

25 These levels were developed following the Water Quality Ladder of the Resources for the Future (Carson and Mitchell, 1993).

incompatible with free-flowing rivers" (Sanders *et al.,* 1990: 1345). They use CVM to estimate both on-site uses, such as recreation use, and off-site uses, such as option value, existence value and bequest value of protecting rivers. Individuals are asked in the CV survey to report their maximum willingness to pay annually into a special fund to be used exclusively for increases in the number of specified rivers protected. Annual benefits of the three most valuable rivers in the state (Colorado) are estimated as $40 per household, including about $8 on-site recreation use value and $32 off-site preservation value. In the Sanders *et al.*'s study, river protection is conceived from a narrow perspective, that is, "protected in their natural free-flowing condition" which does not represent the situation in developing countries like Bangladesh where many alterations have already been done to rivers (e.g. encroachment on the river and narrowing of channels).

Green and Tunstall (1991) employ the CVM to estimate the recreational benefits resulting from improvements in river water quality in the UK. They estimate benefits within a TEV framework. Although they recognize the importance of non-use values, Green and Tunstall do not try to separate WTP for use values from non-use values. They state that "[i]n addition to the substantial national economic benefits through recreation of improved water quality, non-use benefits also appear to be large. However, it is not currently possible to attach accurate estimates of non-use value to particular river reaches" (p: 1144). The annual benefits resulting from improvements in river water quality is estimated as $1203 per household, using increased water rate as the payment vehicle.

Carson and Mitchell (1993) estimate the national benefits of freshwater pollution control using data from a contingent valuation survey in the USA. They estimate the aggregate benefits of meeting the goals of the Clean Water Act of 1972. Water quality benefits have been set against a clearly mandated goal of achieving waters fit for three progressively higher levels of water quality (e.g. boating, fishing and swimming). The payment vehicle used in the study is annual taxes and higher product prices, and the elicitation procedure used is a payment card format. The study reveals that residents are willing to pay on average $106 annually for maintaining boatable quality water, $80 more to reach the fishable minimum water quality level and an additional $89 to move from the fishable minimum quality to a national minimum of swimmable quality water which gives an unadjusted mean total of $275. Carson and Mitchell also compare their CV results with those of Smith and Desvousges (1986) to examine the part-whole bias.

Smith and Desvousges applied CV for a regional fresh water resource, the Monongahela River Basin in the USA. The study of Carson and Mitchell rejects the part-whole bias.

Tunstall *et al.* (1999) apply the CVM to examine the stability of public responses to an urban river restoration scheme on the River Skerne, UK, by comparing the results from surveys of local residents carried out before and after the implementation of the scheme. The survey largely conformed to the NOAA Panel guidelines. Exploratory CV results on whether or not local residents are prepared to pay for the scheme are found to be broadly stable over the two surveys, i.e. surveys conducted before implementing the restoration scheme and after the completion of the scheme.

Berrens *et al.* (2000) use the CVM to measure non-use value of protecting instream flows of water in its natural channels without diversion in New Mexico rivers. The benefits valued are recreational activities, enhanced water quality, and protected biodiversity and riparian areas, using a dichotomous choice format and voluntary contribution payment vehicle (i.e. to buy or lease water from willing parties) for a period of five years. The study does not make any attempt to decompose total value, rather focuses on "the protection of minimum instream flows (not recreational optimal flows), and endangered and threatened fish species that are not legally or preferentially targeted by anglers" (Berrens *et al.,* 2000: 75). Results from the CV survey indicate significant non-market values for the protection of New Mexico instream flows: the median annual household WTP values for protecting minimum instream flows is approximately $25 for the Middle Rio Grande River and approximately $55 for the four other rivers in New Mexico.

Among the rivers in Thailand, the Chao Phraya River is the most polluted one. Uncontrolled urban sewage discharge is considered to be the major cause of water pollution for this river. Tapvong and Kruavan (2000) apply the CVM to estimate Bangkok residents' willingness to pay for improved water quality through financing a central wastewater treatment facility. Respondents were presented two possible water quality scenarios; *scenario 1* offering improvement of the water quality from 'boatable' to a level where fishing could take place, and *scenario 2* offering further improvement of the water quality from 'boatable' to a level where swimming is possible. The total sample of 1100 households was given four versions of the questionnaire. By using a dichotomous choice CV method, the mean values for the treatment of water quality scenario 1 and 2 are found to be 100.81 and 115.03 baht/month respectively. The result also indicates a significant positive relationship between the respective referendum amount and stated amount.

Markandya and Murty (2000) analyze the case for cleaning the Ganga (Ganges) River in India. The cleanup of the Ganges or the 'Ganga Action Plan (GAP)' originated from the personal intervention and interest of the then Prime Minister of India in 1979. However, implementation of the first phase started in 1985. The main objective of the GAP was to raise the river water quality to bathing standard (as thousands of religious bathers use the river every day). The GAP made an attempt to compare costs and benefits of the programme in the form of an CBA, largely on an *ex post* basis. The final cost of the GAP has been estimated as Rs 700 crore or Rs 7 billion for phase I and Rs 420 crore or Rs 4.2 billion for phase II. The operational costs of the programme run to around Rs 356 million. The GAP consists of schemes for the diversion and interception of industrial and household effluents via the construction of sewerage treatment plants, schemes of low cost sanitation, electric crematoria, schemes for riverfront development and others. Benefits, both tangible and intangible, are quantified. Non-use benefits of the GAP are measured using the CVM. However, the respondents' value elicitation mechanism does not take into account the fact that the extremely poor residents living in the Gangetic basin may not be willing to pay any monetary contribution due to their extreme poverty. However, this does not mean that the cleanup programme is less important to them. The CV survey designed for the GAP study fails to capture this significant aspect.

The literature review on river cleanup issues reveals that the value of water quality improvements seems to be assessed on an *ad hoc* or piece-meal manner. Garrod and Willis (1999), for example, commenting on the UK Environment Agency, note that it seeks "to meet specified targets for improving bathing water quality, river water quality, and low flows in rivers, rather than using environmental valuation or other systematic approaches to judge the efficiency of investment in these activities" (p: 365).

Another important issue is that the cleanup programmes have traditionally focused on the benefits and costs of recreational use, particularly on fishing related benefits (Cropper and Oates, 1992). Several studies have estimated aspects of demand for improved water quality for water-based recreation (e.g. Smith and Desvousges, 1986). Others have estimated the costs of water quality improvement or waste water abatement cost (Abelson, 1996). While the present study is concerned with the estimation of benefits and costs of cleaning up the dying river, it differs from earlier works by introducing a holistic approach to the cleanup programme. The river water quality issue has been put into a broader perspective. Instead of defining it either as maintaining of river flow or controlling pollution (particularly industrial effluents), or establishing wastewater treatment plant, the cleanup issue is defined as a combination of both quality and quantity issues. The cleanup programme is expected to potentially increase the quantity and quality of the resources. The value of increases in the supply or quality of resource is reflected by any resulting increase in the public net WTC (demand) for these goods.

Furthermore, problems with applying the contingent valuation technique that are particular to developing countries focus on (i) lack of well-functioning markets; (ii) data problems, such as lack of records of sale prices; (iii) high cost of a survey; and (iv) lack of trained manpower (Georgiou *et al.,* 1997). None of the studies examines the applicability of CVM in the developing country context.

Some of the findings from the literature review are as follows: (i) although a considerable number of studies have been conducted, studies in developing countries are still few; (ii) most studies have a narrow policy scope, i.e. scenarios considering both quality and quantity issues are missing; and (iii) the desirability of public investment in the cleanup programme in the context of developing countries, particularly for extremely poor economies, is yet to be examined.

3.4.2 Contingent Valuation Scenario for the Buriganga River Cleanup Programme

A description or an appropriate specification of the contingent market is important for at least three reasons: first, to identify resources to be valued; second, to avoid some of the biases[26]; and third, to design a "with-programme" scenario which is essential for the cost-benefit analysis (this is discussed in greater details in *Chapter Six*). The economic analysis of environmental improvement requires comparison of the project viability under the "with" and "without" project/programme situations. In keeping with the "with and without" principle, the "with-programme" benefits need to be defined.

Careful specification of the scenario is critical when CV is used to value complex and unfamiliar goods such as environmental improvement. A key specification issue has to do with the scale or scope of the good. A good can vary in geographic scale (e.g. one river or several rivers), policy scope (e.g. water quality improvement or improvement of the water and the river-banks), or time-scale (e.g. development for one year or many years). All these need to be specified. Only issues related to the policy scope are discussed here. The remaining issues will be discussed in the next chapter with regard to the design of the survey instrument.

The specification of the proposed cleanup programme differs from other cases discussed. The limitation of the existing cleanup approach is that it focuses on single issues addressed in isolation (e.g. erosion control and flow maintenance/restoration). The Buriganga River cleanup programme has been put in a broader perspective in this study, beyond mere water quality improvement. That means the policy scope is much more holistic. Environmental improvement is considered as a public good, part of which will be passed onto the residents through market transactions and the rest will be provided free of charge.

Therefore, the hypothetical scenario, or 'with-programme' scenario, designed for this study includes the following activities:

- Demolition of illegal structures in the Buriganga River;
- Wastewater treatment plant for the industrial effluent in the Hazaribagh tanneries;
- Improvement of solid waste collection and disposal through government-private sector partnership;
- Regular maintenance dredging of the riverbed;
- Creating an environment for recreation and tourism activities along the riverside;
- Construction of access road to the river and walkway along the river; and
- Closure of sewer lines into the river.

The whole cleanup programme is designed to go through three phases. In the first phase, which is aimed to be achieved in the short term (within a two – three year period), human usages of the river water, such as rowing, boating, swimming, and picnicking will become possible.

In the second phase, which is aimed to be achieved in the medium term (within a five year period), the river water could be used for irrigation in the downstream, fishing (in the sense that more fish will be available in the river) and other agricultural and industrial uses.

In the third phase, which is aimed to be achieved in the long term (at the end of the 10 year period for the proposed programme), the river water could be used for drinking

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[26] Details of biases are described in the next chapter.

after simple treatment. As the water quality improves, more highly valued varieties of recreation become possible. Also, as the water is expected to gain the reputation of being gradually improved, many activities such as boating, swimming and picnicking, will eventually increase[27].

Other aspects of the contingent market, such as the institutional context in which it would be financed, payment mode and the duration of payment are discussed in the next chapter when describing the survey design.

3.4.3 Defining the Benefits to be Valued

This section defines the benefits of the Buriganga River cleanup programme within the framework of TEV described in Section 3.1.2 of this chapter. In Table 3.1, an attempt is made to desegregate the economic values (benefits) of the cleanup programme into different components of total value. The components of the TEV are defined on the basis of the ECV scenario which is expected to be the potential benefit of the Buriganga River cleanup programme. The total value is, therefore, the sum of all these components; not just those that can be measured from market information.

Table 3.1 presents the appropriate method to estimate each component of the Buriganga River cleanup programme. Within the framework of TEV, only some direct use benefits will be estimated using market data; all other components of TEV will be measured using the ECVM due to either non-existence or malfunctioning of markets.

In the case of the Buriganga River cleanup programme, benefits are expected to accrue to the households both directly (mainly use values) and indirectly (mainly non-use values) – directly through increased provision of goods and services (e.g. an increase

[27] There are trade offs between the component values in the TEV framework designed in the following section. For example, more recreational activities can potentially pollute the water if not carried out properly.

Table 3.1: *Taxonomy of the total economic value of the Buriganga cleanup programme*

Components of TEV	**Technique to Measure Value**
Use Value	
Direct Use Values	
Consumptive Uses	
• Water transport (navigation)	Market data
• Increased fish production	Market data
• Better quality water for domestic and industrial uses	Market data
Non-consumptive Uses	
• Increased housing and land values	Market data
• Jogging and walking along the river	ECVM
• Tourism and recreation	Market data
• Educational, scientific and cultural purposes	ECVM
• Improved health benefit	Market data
• Bathing, washing and boating	ECVM
Indirect Use Values	
• Riverbank erosion prevention	ECVM
• Flood control	ECVM
• Reduced damage to downstream irrigation system	ECVM
• Biodiversity	ECVM
• Ecological function (e.g. watershed protection)	ECVM
• Pollution assimilative capacity	ECVM
Non-use Values	
Option Values	
• Biodiversity	ECVM
• Future use (e.g. recreation option)	ECVM
• Potential gene pool	ECVM
Existence Values	
• Satisfaction from knowledge of existence of clean water	ECVM
• Aesthetic benefits	ECVM
• Biodiversity	ECVM
• Spiritual and religious	ECVM
Bequest Values	
• Value arising from the knowledge that the river remains healthy and viable and will persist for future generation	ECVM
• Biodiversity	ECVM

in the volume of river transportation), improved quality of the existing facilities (e.g. improvement of water quality), and newly created facilities (e.g. use of river water for domestic needs, and tourism and recreation), and indirectly through the existence of a healthier environment both for current and future generations. That is why, except for few use values, all the components of TEV are used to elicit residents' WTC for the cleanup programme.

3.5 Conclusion

The focus of this chapter is on developing the conceptual basis and theoretical foundation for this study. It analyzes the concept of value from an economic perspective, defines total economic value and then discusses the analytical and theoretical framework within which estimation of economic values are formulated and interpreted. The chapter describes theoretical measures of welfare change derived from responses of hypothetical questions through ECV survey. Responses to direct questions about WTC, both in the form of money and time, can be interpreted as estimates of each individual's preference for the good in question. The ECV method can be used in a "total value framework" considering the non-market components of the TEV resulting from the cleanup programme.

A review of the literature on the theory and application of CVM reveals that the conventional approach is unable to capture the issue of non-monetization of many economies. This indicates that the respondents' preference evaluation through asking their willingness to pay might not capture full value elicitation in the context of developing countries like Bangladesh. To overcome this drawback, an extension is proposed, i.e. a question asking respondents' willingness to contribute time, along with the conventional approach of asking the WTP question. This proposition is examined in the next chapters.

Previous empirical studies on the application of CVM in regard to river cleanup programmes are also briefly reviewed. The contingent market is also defined and resources needed to be valued through ECV survey are identified. These are important for designing the survey instrument and to design a cleanup programme for the Buriganga River, which are the subject of *Chapter Four* and *Six* respectively.

As a whole, this chapter lays out the basic premises and value judgements that underlie the economic concept of benefits and presents the basic theory of the measurement of economic welfare changes. How to apply these theories and estimation of values are the subjects of the chapters to follow. An ECV survey procedure is designed in the next chapter and the data generated by the survey is analyzed in *Chapter Five*. In *Chapter Six*, all the data and information are compiled together to construct a cash flow to conduct an extended cost-benefit analysis on the basis of the theoretical framework designed in this chapter.

Alam, Khorshed. (2003). *Cleanup of the Buriganga River : integrating the environment into decision making*. PhD Dissertation. Perth, Murdoch University.

Chapter Four

METHODOLOGY, SURVEY DESIGN AND DATA COLLECTION

4.0 Introduction

The aim of this chapter is to describe the methodology and design of the survey procedures to be used to estimate the non-market benefits of the cleanup programme outlined in the previous chapter. A variety of data (both market and non-market) are gathered from primary and secondary sources using a number of methods. These methods are described with a detailed focus on the survey design procedure adopted for this study. Potential biases associated with the ECV survey are described along with the measures adopted to control them.

The chapter is divided into eleven sections. Section 4.1 describes the various methods of data collection. Section 4.2 introduces the survey design procedure, particularly the choice of delivery mode, target population and unit of analysis. Section 4.3 presents the designing of the sampling frame and sample selection procedure which is followed by an outline of the fieldwork and the data collection procedures in Section 4.4. The survey instrument is elaborated in Section 4.5 and the elements of the contingent valuation interview schedule are presented in Section 4.6. This is followed by the framing of the valuation question (Section 4.7), a discussion of the reliability and validity issues of survey design (Section 4.8) and an analysis of the potential sources of biases and remedial measures adopted in the study (Section 4.9). Section 4.10 describes the method of data analysis and selection of test statistics. Conclusions are drawn in Section 4.11.

4.1 Methods

Various methods are used to generate data and information to meet the requirements of this study, namely: (i) a case study; (ii) survey; (iii) use of secondary sources; (iv) benefit transfer; (v) direct observation; and (vi) focus group discussions. The main source of information is a household survey in Dhaka City and a significant portion of the data, particularly relating to non-market benefits, is collected through this survey. The various methods used are described below and the remainder of the chapter focuses on the survey design.

Case Study: The Buriganga River is selected as a case study for this study. The conceptual and theoretical framework for estimating non-market benefits and for integrating them with the economic analysis, developed in *Chapter Three*, is applied for this selected case. Data on the Buriganga River system, uses of the river, level of water pollution and sources of pollution were collected to give a good picture of the Buriganga River. To design a cleanup programme, detailed data were collected both for point and non-point sources of pollutants, following many visits along the river-bank. Three boat trips were also made, starting from Sadarghat Terminal to Bangladesh-China Friendship Bridge, Z. S. Medical College to Shawarighat and from Gabtali to Z. S. Medical College. All data and information were collected and the field visits for this study were conducted between February and June 2001.

Survey: The contingent valuation technique is applied to measure the economic value of environmental improvements regarding the BRCP. Data on non-market goods and services is totally unavailable in Bangladesh because of the absence of market for most of the goods expected to be generated by the cleanup programme. A survey instrument based on the concept of contingent valuation was designed to generate primary data relating to the proposed programme's non-market benefits. The classification of TEV, described in *Chapter Three*, was used to value all the non-market components of environmental benefits of the BRCP. Details of the survey procedure are described in the next sections of this chapter.

Use of Secondary Sources: Secondary information is required in relation to the overall costs of the different components of the BRCP and in order to describe various situations throughout the study. Observed market prices are used for the cost estimates. Data for the implementing costs of the cleanup programme are collected from many sources. Different agencies separately calculate various cost components of the activities which are included in the Buriganga River cleanup programme, and these are assembled and used with appropriate adjustments. Secondary data from a wide variety of sources, such as government departments, private sector and non-government organizations (NGOs), are collected (for a complete list of sources, see *Appendix I*). Additional data and information are collected/compiled from a wide range of sources including:

- newspapers,

- scientific journals and periodicals,
- published and unpublished reports, monographs and other literature,
- research reports (draft and completed),
- test results from laboratories, and
- official and institutional records.

Many face-to-face open-ended interviews and discussions were held at different government, semi-government, autonomous and non-government departments and offices during the course of data collection from secondary sources. These *personal communications* provided not only an in-depth insiderview of the problems, but also were helpful to collect much unpublished information and to update the published data. *Expert opinions* were sought for cost estimates of different components of the Buriganga River cleanup programme. The face-to-face consultations with departmental experts were instrumental in deriving appropriate estimates for this study. They include concerned officials, consultants and experts working with the Bangladesh Inland Water Transport Authority (BIWTA), Dhaka City Corporation (DCC), Dhaka Water and Sewerage Authority (DWASA), Ministry of Industries (MOI) and Waste Concern (WC). Many of the estimates which government departments made for their own consumption were modified to be used in this study after consultation and on the basis of expert advice. The main areas of data and information collected for this study and their sources are summarized in Table 4.1.

To investigate the emerging threats to rivers in Bangladesh, a content analysis of national daily newspapers was conducted. Six vernacular national dailies were selected: two in the local language (Bengali), *The Daily Prothom Alo* and *The Daily Janakantha,* and four in English, *The Daily Star, The New Nation, The Independent* and *The Bangladesh Observer*. The timeframe for this analysis was between January 1, 2000 and June 30, 2001. Data and information for the study were collected as of June 2001; only in few cases, some updated data beyond this timeframe were used. For instance, the preliminary report of the 2001 Population Census, used in this study, was released in August, 2001. Also, updated information particularly in regard to the Buriganga River, the vulnerability of rivers in Bangladesh and utility services of Dhaka City was collected up until mid-September, 2003 mostly from the internet edition of the six Bangladeshi daily newspapers mentioned above.

Table 4.1: *Description and sources of secondary data and information*

Description of data/information	Sources[a]
Buriganga River: water quality, encroachment, dredging	BIWTA, DDA, DOE,
Development projects on the Buriganga River: PP/PCP of different on-going projects	BIWTA, DWASA, MOI
Dhaka City population data	BBS
Civil society activities on the Buriganga River	BAPA, DOE, MOEF, POROSH
Content analysis of national dailies (old copies)	PD library and SSRC
Industrial pollution and cost estimates of tannery effluent treatment plant	DWASA, MOI and exporters' association
Investment data: public sector, water sector and environment	PC
Maps: Bangladesh river system, Buriganga River system, Dhaka City, Buriganga River showing adjacent districts and GBM Basin	BBS, SWMC
Policy issues: environmental rules, regulations and policies in Bangladesh, water sector policy and planning, policies related to rivers	DOE, MOEF, MOWR
Sewerage service: existing service and expansion	DWASA
Solid waste management	BCAS, DCC, WC
Water resources and river system in Bangladesh	MOWR, WARPO
Water supply and projection for Dhaka City and treatment cost	DWASA
Voters list for sampling frame	District Election Office

Note: [a] Full names of the sources are provided in *Abbreviation and Acronyms* and in *Appendix I*.

Benefit Transfer: Benefit transfer[1] involves "taking the results of an existing primary valuation study and transferring those findings to another context, e.g. a different geographic area" (Eiswerth and Shaw, 1997: 2381). Monetary values obtained from other valuation studies are used in this study with appropriate adjustments, such as adjustment of the original study value to the current year value using the consumer price index (CPI).

Direct Observation: I lived for more than a decade between 1990 and 2000 within half a kilometre of the Buriganga River. Direct observation played an important role in shaping the research design for this study. During the fieldwork (i.e. between February and June, 2001), extensive visits were made to the Buriganga River. Boat trips on the

[1] Although called benefit transfer method, values and estimates of both costs and benefits can be transferred.

Buriganga River helped to identify sources of pollution, particularly point sources and also to illustrate the extent of the damage that has been done to the river.

My work experience with the Bangladesh Planning Commission (national planning agency responsible for formulating macro-plans and processing of public sector development projects for approval), Bangladesh Bureau of Statistics (official custodian of all national and local level data), Bangladesh Inland Water Transport Authority (custodian of the waterways including the Buriganga River), Bangladesh Public Administration Training Centre (peak training institute for civil servants) and Bangladesh Institute of Development Studies (an autonomous think-tank for socio-economic research) for more than a decade also provided important insights into the policy decision-making process and planning mechanism in Bangladesh.

During the fieldwork in 2001, I also participated in some civic group activities under the banner of *Buriganga Bachao Andolan* (Save the Buriganga Movement). These activities were aimed to create pressure on regulatory authorities and to build awareness among the public and included participation in rallies, attending meetings related to organizational and operational issues and arranging essay and drawing competitions among children.

Focus Group Discussions: In addition to the previously described five methods, many Focus Group Discussions (FGDs) were held in the study area. There were two reasons for undertaking such discussions. First, FGDs were used to shape the interview schedule (IS)[2]. Four such FGDs were held in the study area during the fieldwork. Second, two FGDs were conducted to obtain the views of policy-making and opinion making communities, practitioners, environmentalists, legal experts, civil society activists and others on the issue of surface water problems, Buriganga River water pollution, sources of pollution and measures to save the river. These discussions provided useful insights to design the cleanup programme for the Buriganga River. The remainder of the chapter focuses on the procedures of survey design including potential biases and methods of data analysis.

4.2 Survey Design

2 In this study, the term 'interview schedule' is used instead of the commonly used term 'questionnaire' as the survey instrument was a face-to-face in-person interview.

A detailed design of the survey procedure is presented in this section and the sections to follow. The theoretical underpinning of the survey is based on the extended contingent valuation method described in the previous chapter.

4.2.1 Choice of Delivery Mode

A CV survey can be conducted by mail (Streever *et al.,* 1998), telephone (Byrnes *et al.,* 1999), in-person interview (Carson *et al.,* 1992 and Kosz, 1996), some combination of these (e.g. for a combination of mail and in-person, see White and Lovett, 1999), or more recently, by an interactive computer-assisted telephone interview system (Berrens *et al.*, 1998). In developing countries like Bangladesh, telephone or mail surveys appear to be impractical and are not common. Many people do not have telephones (more than 80 percent in Dhaka City) and, normally, telephones belong to the richer class of the population. On the other hand, there is no list of mailing addresses or street directory and the mailing system is not reliable. Many people are illiterate and do not have the ability to read mailed survey information. The unfamiliarity and difficulties with phone or mail techniques together with the educational backwardness of the general mass of people led to a decision to conduct an in-person survey. Mitchell and Carson (1989) point out another advantage of in-person surveys. This is the method of choice for most CVM studies because interviewers can motivate respondents to make a greater effort to give dollar values, can control the pace and sequence of the interview and are able to explain complex scenarios.

4.2.2 Target Population

The definition of the target population for the survey needs to be considered when the aggregate CV estimate is made. The target population of the survey is residents of Dhaka City residing in a house – be it an independent house, an apartment, a flat or a shanty. Institutional households, such as hostels, hospitals, clinics, nursing homes, jails, barracks or orphanages and floating people were excluded from the target population as they do not form a household for tax purposes. A residence-cum-office/business was considered to be a household. It was decided to confine the survey within Dhaka City mainly because of the time and resource constraints and on the basis of the understanding that these residents are the immediate beneficiaries of the BRCP, although some components of total value, particularly non-use values, should not be confined by this boundary.

4.2.3 Unit of Analysis

Another consideration which needed to be addressed was whether the valuation data should be collected for households (Carson *et al.,* 1992 and McConnell, 1995) or on an individual basis (Kealy *et al.,* 1990 and Imber *et al.*, 1993). Wilks (1990) points out that this decision is dependent upon the type of payment vehicle selected and whether such payments are usually made on a household or individual basis. The payment vehicle chosen for this study is an increase in the water bill[3] and this suggests the household as a unit of analysis.

Given the household as unit of analysis, the reference income used is the household's rather than the individual respondent's income. The reason for choosing 'household' as the unit of analysis is also linked with the cultural practice in Bangladesh. In most cases joint-family structure still exists and incomes are joined together for the purpose of any expenditure decision. Also, all utility bills are collected on a household basis. All these justify the choice of 'household' as a unit of analysis. The BBS's definition of household, namely a dwelling place where "person or persons related or unrelated [are] living together and taking food from the same kitchen" (BBS, 1993: 3), was adopted for this study.

4.3 Sampling Frame and Sample Selection Procedure

The study area (i.e. geographic boundary) of this research is restricted to Dhaka City, the capital of Bangladesh on the bank of the Buriganga River (the study area can be seen on Map 2.3 in *Chapter Two*). Considerable differences exist about where the boundary of Dhaka City lies. Various utility, service organizations and departments have demarcated it for their own purposes[4]. The demarcation of the Dhaka City Corporation (DCC) is applied mainly because BBS has adopted this demarcation for their Population Census which is used for this study's sample frame.

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[3] The reasons are discussed in details later in Section 4.7.3.

[4] The Dhaka metropolitan area defined by the RAJUK is 1508 sq km which includes Savar, Tongi, Gazipur, Narayanganj and Keranigang. The DWASA service area is 380 sq km. The DCC area is 360 sq km. The BBS also uses the concept of statistical metropolitan area (SMA) with an area of 1530 sq km which is an agglomeration of the DCC, four other adjacent municipalities (e.g. Narayanganj, Tongi, Gazipur and Savar), several cantonments and a large number of rural settlements.

Dhaka City, as defined by the DCC[5], is comprised of 14 thanas[6] and each thana in turn contains about 4 to 17 wards. In total, there are 90 wards as per the 1991 statistics[7]. Each ward is again divided into a few mohallas. Each mohalla contains one or a few streets and a varying number of households. Altogether, there are 659 mohallas and the total number of households in Dhaka City is 643,016 (BBS, 1993). A description of the target population and selected samples is provided in Table 4.2. Both population and survey data are divided into 'Buriganga River area (BRA)' and 'outside Buriganga River area (OBA)'[8].

In selecting a sample from this target population of the survey, the important consideration was how to identify or select the respondents among the population (i.e. from more than 643 thousand households). One of the options would have been to use the voters' list. However, during the period of the sample frame design and survey, a new voters' list was being prepared to be used in the October 2001 general election and it was considered as a 'confidential document' at that stage. Furthermore, although in many studies the voters' list has been used as a sampling frame, it was not considered a reliable sample frame because the unit of analysis in this study is the household (the voters' list contains only the individual adult population).

Table 4.2: *Profile of population and sample at a glance*

Name of thana	**Total of DCC**			**Selected for survey**		
	Ward	**Mohalla**	**Household**	**Ward**	**Mohalla**	**Household**
Kotwali	8	97	31988	-	-	-
Lalbagh*	11	119	57248	2	4	75
Mirpur	10	87	113353	-	-	-
Mohammadpur*	7	48	57551	2	4	61
Sutrapur*	11	81	49286	2	4	61
Subtotal (BRA)	47	432	309426	6	12	197
Cantonment	2	19	29761	-	-	-
Demra	5	23	52444	-	-	-
Dhanmondi*	4	30	33451	2	5	42

[5] The DCC, an autonomous local government body under the Ministry of Local Government, Rural Development and Cooperatives, is run by an elected Mayor and 90 elected Ward Commissioners (one Commissioner for each Ward).

[6] A thana is a type of sub-district. The whole country is divided into 64 districts (called zila). Each district is divided into several thanas. To avoid confusion, it should be mentioned that a police station is also known as 'thana' in Bangladesh.

[7] The third Population Census was conducted in 1991 and the fourth in January 2001. During the present survey and data collection, the results of the 2001 census had not been published. That is why for the sampling frame, the 1991 population statistics are used. However, for aggregation purposes, population data of preliminary results from the 2001 Census, released by BBS in August, 2001, are used.

[8] Details are discussed later in this section.

Gulshan*	5	39	38048	2	4	53
Motijheel	6	35	36059	-	-	-
Ramna *	5	27	30851	2	4	42
Sabujbagh*	9	30	55919	2	4	66
Tejgaon	4	20	37644	-	-	-
Uttara	3	4	19413	-	-	-
Subtotal (OBA)	43	227	333590	8	17	203
Total (DCC)	90	659	643016	14	29	400

Notes: * indicates selected for the survey
DCC: Dhaka City Corporation, BRA: Buriganga River area, and OBA: Outside Buriganga River area.

Source: Own compilation. Population data is adopted from BBS (1993).

Another difficulty in identifying a household is that in many cases more than one household may live in one unit or even in one room. All these issues posed a problem in establishing a reliable and representative sampling frame. Under these circumstances, it was decided to construct a sampling frame for this survey using the following methods.

Stratifying the Population: To make sure that the samples were representative of the population, a stratified simple random sampling technique, based upon Czaja and Blair (1996), Sarantakos (1998) and Kumar (1999), was employed to select a sample of 400 households (see Table 4.2). Besides ensuring representative sampling, the purpose of stratification was to examine any variation between people living near the Buriganga River and those living at a greater distance[9] with regard to various attitude-behaviour attributes.

From the start of the design of the sampling frame, the whole study area (i.e. Dhaka City) was stratified into two constituents: 'Buriganga River area (BRA)' (i.e. boarding on the river) and 'outside Buriganga River area (OBA)'. This division roughly corresponds to the demarcation of 'old Dhaka' and 'new Dhaka'[10]. Accordingly, five thanas fell within the Buriganga River area (BRA), and nine thanas fell outside. Three thanas from BRA and four thanas from OBA were selected randomly for the survey. The sample of 400 households was then drawn from these seven thanas in proportion to each

[9] Stratification also satisfies the probability sampling criterion, i.e. each and every member (household) has an equal chance of being selected.

[10] Some adjustments were required to justify this demarcation. As distance is the basis of this demarcation (BRA is defined as within one km from the Buriganga River), one mohalla (Lalmatia) of Mohammadpur thana was found to be more than one km distant from the Buriganga River although it belonged to BRA and another mohalla (Hazaribagh) of Dhanmondi thana was found within one km distance from the Buriganga River. These two mohallas were swapped with each other's constituents.

thana's population, resulting in 42-75 households being assigned to each thana (see Table 4.2). Then from each thana, two wards were selected and from each ward two mohallas were chosen. These resulted in 14 wards, 29 mohallas[11] and 400 households (197 households from the Buriganga area and 203 households from outside the Buriganga). All these selections were based on a random procedure. Further details of the selected thanas, wards and mohallas are provided in *Appendix II*.

Household Selection: After selecting a mohalla, trained enumerators[12] were sent to that mohalla. At first, they observed the physical location of the mohalla. Then they started listing the households from the north-west corner of the mohalla (for sampling frame, see *Appendix III*). They listed all existing households in the mohalla starting from the right hand side and moving to the left hand side of each street. After finishing the listing of households, they started the interview process. Among the listed households, every 20th household was selected and interviewed to ensure that the samples were random. In a selected household, if nobody was found or answered the door for the house visited, or the person needed for the interview was not available, interviewers were required to re-visit the household two more times on a different day. In the case that the household was still non-contactable, residences located before and after that household respectively were used as a 'replacement sample'.

Respondent Selection: Selecting a household was not the end of the sample selection procedure. After selecting a household, the task was to identify a participant from that particular household. For that purpose a 'contact sheet' was developed (see *Appendix IV*). The interviewer first sought permission of the contact person (i.e. the person who answers the door) to randomly select a participant from the members of the household to participate in the survey. To do this, all the eligible members[13] were listed by their nickname[14] and gender, then a participant was selected using the 'random number table'

[11] From ward 20 of Dhanmondi thana, one additional mohalla (Science Laboratory) was required to be selected to complete the 42 households because of the inadequate number of households in the two selected mohallas (Dhaka College and Elephant Road). This resulted in there being three mohallas in ward 20.

[12] The training process is discussed later in this chapter.

[13] Two criteria were used for eligibility of a participant for being selected, i.e. (i) 18 or above years of age, and (ii) mentally and physically fit. Servants, caretakers and security guards were excluded from the survey. Although they, particularly servants, live with the household and share the same food, they were excluded from the sample frame for several reasons. These are: (i) they appeared extremely shy or reluctant to express their opinion in the presence of any family member; (ii) they were not allowed to be interviewed in many instances; and (iii) due to custom/culture, many did not recognize them as members of household.

[14] Due to cultural practices, in some instances, the contact person (particularly in the case of conservative women) appeared to be shy to name the elder members of the household. In that case, serial number was used.

designed for the survey (see *Appendix V*). If it was the contact person who was the selected respondent then the interview was started if she/he agreed or an appointment was made for another time. If the respondent was other than the contact person, then either the interview was started or an appointment was made for another time. All the interactions were in Bengali, the local language.

4.4 Fieldwork and Data Collection Procedures

The fieldwork for this research was carried out over a five-month period from February to June 2001. The survey was administered by five interviewers whom I trained and supervised. They were trained in the technical issues of the contingent valuation method as well as in the nature of the interview process, the survey purpose, the principles governing the design of the interview schedule, interviewing techniques, and possible interviewer bias. Part of the training included attending FGDs where the details of the IS were worked out. In the training session, each survey question was explained carefully and questions discussed and answered. Also, mock interviews were conducted during the training process. Four interviewers were male and one was female.

The survey was received very positively by the respondents, although they were not paid for their time. Many respondents found the survey interesting and informative and gave it careful consideration. For many participants, it was the first time they had been interviewed. It was revealed that respondents in the study area did not have any prior experience of expressing their preferences in monetary terms. On many occasions, interviewers were entertained with tea and biscuits, the traditional way of entertaining guests in Bangladesh. On one occasion, one interviewer was offered dinner as it was raining outside and the interviewer stayed in that house for more than two hours.

Interviews with 400 households were successfully completed out of 470 total contacted households. In each ward, the interviewing process continued until the required number of interviews was achieved. At the end of each week, the completed IS were collected from the interviewer and checked for item non-responses and inconsistencies. Only a few discrepancies were noticed during this monitoring process and the respective IS was then sent back to the interviewer for corrections. It was possible to re-contact most of these households and recover the missing information. An interview took an average of 24 minutes. The shortest and longest times are 17 and 61 minutes respectively. The overall response rate was 85.10 percent (for details, see

Appendix VI). This was possible due to the large effort that was put into locating difficult-to-find respondents, convincing/overcoming refusals and in-person interviews.

4.5 Survey Instrument

An initial version of the interview schedule was developed over a two-month period of intensive experimentation in December, 2000 to January, 2001 at Murdoch University, Australia[15]. After returning to the study area, four open-ended focus group discussions (FGDs) and ten trial (one-on-one) interviews with potential respondents were conducted. The interview schedule was then piloted with twelve households. The survey instrument was continually revised to address various problems that had become apparent in the FGDs, trial interviews or pre-testing with the respondent. The design of the survey instrument was undertaken through the following stages.

Focus Group Discussions (FGDs): A series of four FGDs were held in different locations around the study area. Each FGD consisted of 9-16 members of adult residents of the study area. The participants were recruited in such a way that the group was representative of the residents by including a balanced number of men and women, a range of ages, educational attainments and different income groups. Each discussion continued for two to two and a half hours. In each FGD, elements of the IS, such as the payment vehicle, the length of payment, the description of the scenario and environmental improvement and use of photographs were described. The purpose was to get feedback on the design of the interview schedule. The FGDs were also used to determine what additional information respondents desired in order to make an informed decision. Upon completion of the FGDs, a draft survey instrument incorporating the valuation scenario and bid values was developed. Ten trial interviews were then conducted where this draft IS was scrutinized. For this purpose, a convenience approach, e.g. stopping some people in the street and knocking on doors at residents' houses, was used.

Pre-testing of Survey Instruments: In order to see whether the right questions were asked and the appropriate information was gathered for meaningful analysis, pre-testing of survey instruments was undertaken to scrutinize their design and procedure. Following Hoevenagel (1994), careful pre-testing was aimed to "enhance the

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15 The interview schedule also received approval from the Human Research Ethics Committee at Murdoch University.

plausibility and meaningfulness of the CV scenario and, at the same time, to minimize the various misspecification biases" (p: 256).

For the pre-test, the same method was followed as intended in the real survey. As well as providing reaction to the bid levels, the pre-testing was used for two other functions: (i) to amend questions in order to ensure that they would be better understood by the respondents (some cases, sentence structure and wording were changed); and (ii) to amend the interviewing technique so that the methods could be improved and standardized. Particular focus was put on how participants responded to the bid values and hypothetical scenario presented to describe potential environmental improvements. The pre-test findings resulted in a number of adjustments to the interview schedule, mostly changes in the wording of some questions, identifying unclear or ambiguous questions and assessing the adequacy of response choices.

In the pre-testing of the survey, it also appeared that the completion rate (i.e. number of interviews per day) was quite low. The reason identified was that the methodology used to select a respondent within a selected household was too complex. As a result, it took several visits to complete an interview. In the pre-testing, interviewers used to start work at 9.00 am in the morning. It was observed that the response rate was very poor, because of the non-availability of the selected respondents at home, particularly with people who are outside the home during the day (e.g. working people and students). Consequently, it was decided that the survey operation would take place in the evening between 4 to 8 pm in the weekdays and 10 am to 6 pm at the weekends. Although this meant a longer period to complete the survey operation, it increased the completion rate. It was also decided to use a replacement sample when there were three consecutive absences of the selected member of a household.

Full-scale Survey: The full-scale survey was conducted between March 30 and June 01, 2001. Time dependence was minimized by conducting all interviews within about two months. No environmental crisis or policy changes took place during this period. The original draft of the interview schedule (IS) was written in English to allow maximum input from a wide range of sources including the supervisor of this research[16]. It was translated into Bengali (the local language) for the actual interviews (including FGDs and pre-test) in Dhaka. The final version included a total of 41

[16] Comments were also sought on the interview schedule from three internet-based discussion groups: Water Forum (http://groups.yahoo.com/group/waterforum), Forum of Ecological Economics (http://www.csf.Colorado. EDU) and Bangladesh Environmental Network (BEN) (http://www.ben-center.org).

questions structured around four sections (for full version of the interview schedule, see *Appendix VII*).

Post Survey Check: A follow up telephone check, four weeks after the completion of the main survey, was conducted to assess the number of skipped questions and to verify the results of the survey, both of which tend to increase the reliability of the survey data. For this purpose, 40 respondents were randomly selected amongst the telephone-equipped households. They were asked by phone[17] whether the interviewer performed their job properly, whether the interviewer was able to explain the scenario and payment method properly and whether the respondents understood these explanations. The consistency of the respondents' answers was also checked by asking several questions again (for full version of the re-interview schedule, see *Appendix VIII*).

4.6 Elements of Interview Schedule

The contingent valuation interview schedule was designed in such a way that a satisfactory transaction could be established. A satisfactory transaction is defined as "a transaction in which people are fully informed, uncoerced and able to identify their own best interests. Satisfactory transaction will result in valid and reliable WTP values which can be used in cost-benefit analysis to test for a potential Pareto-improvement: i.e. the economic objective of the CV method" (Hoevenagel, 1994: 196). Following Fischhoff and Furby (1988), as Hoevenagel (1994) states "a satisfactory transaction will take place, if the good, the method of payment and the market are well defined and well understood by the respondent" (p: 196). Translated into the CVM, this means that any structure of IS should consist of three elements: (i) a description of the environmental change, that is, the benefits to be obtained from the goods; (ii) a description of the method of payment; and (iii) a description of the hypothetical market. Hoevenagel (1994) suggests adding a fourth element, i.e. a question related to the respondent's attitude towards the described environmental change or their attitude towards paying for that change. Such questions are used for (internally) validating the elicited WTC values. According to Fuguitt and Wilcox (1999), the CVM consists of (i) hypothetical market scenario; (ii) sample selection; (iii) survey instrument; (iv) valuation question(s); (v) value estimation; and (vi) response validity and reliability tests.

[17] The use of phone interviews did not affect the reliability of results as it could not cause bias.

Based on Fischhoff and Furby (1988), Mitchell and Carson (1989), Hoevenagel (1994) and Fuguitt and Wilcox (1999), the IS was designed to be understandable, plausible and meaningful to respondents. The interview schedule was structured around four sections in addition to an introductory statement and at the end three questions seeking the interviewer's opinion about the survey quality. In the introductory statement, the purpose of the survey was mentioned without disclosing the specific subject of the study. The respondents were also assured that responses were to be used for research purposes, that their co-operation to that effect was sought and confidentiality would be maintained. The contents of major four sections of the survey are described below:

(i) Opinion: Respondents' opinion on various general environmental issues and specific to the state of the Buriganga River was sought in this section. Respondents were initially asked to evaluate Dhaka City as a place to live on a six-point scale: (i) very good; (ii) good; (iii) so so; (iv) bad; (v) very bad; and (vi) don't know. Then they were asked to identify the five most important environmental problems. Respondents were asked to reply whether they knew that Dhaka City is surrounded by rivers, and if they knew, to name them. The next question was whether they had visited the Buriganga River in the last three years and, if so, the reasons for such visit(s). Respondents came to know for the first time the Buriganga River's relevance/importance to this study when this particular question was asked[18].

The questions to follow asked whether respondents were concerned about the Buriganga River and their reasons for such concern, opinion about water quality and reasons for deterioration if they considered the quality was deteriorating and whether the deteriorating water affected them. These questions provided useful insights into the attitude and behaviour of survey participants with respect to resource use issues. These questions were also designed to reveal the respondent's perception of environmental issues and to collect information on the underlying values and beliefs that a resident holds about the surrounding environment.

(ii) Respondents' Priorities: The questions in this section were designed to capture the environmental priority of the respondents. The first question asked respondents to identify four priority areas of development for the Buriganga River. The next question

[18] The reason for avoiding any reference to the Buriganga River prior to this question was to examine the familiarity of respondents with the river.

sought their opinion about the future use of the resources of the Buriganga River if these were restored or developed under the proposed cleanup programme.

(iii) Willingness-To-Contribute: At the beginning of this section, respondents were informed of the major sources of pollution and their effects on the potential uses of the river water, including the high level of contamination existing in water, the odour problems in specific areas, the general environmental degradation that affects fishing, boating and the aesthetic quality of the river. The specification enumerated the interventions required to improve the existing situation, including the construction of sewer lines and treatment plants, improved solid waste collection and disposal and industrial pollution control. Information was provided on the quality and reliability of provision, its timing and logistics and the method of payment. The scenario also included the institutional context in which the goods and services would be provided, the initial level of goods provision, changes in this level and availability of substitutes. Respondents were reminded of the need to make compensating adjustments in other types of expenditure to accommodate this additional financial transaction. While describing the valuation scenario, photographs of the current state of the Buriganga River were shown to the respondents to supplement the information that was read to them and to visualize important aspects of the scenario (for details about the hypothetical scenario, see *Appendix IX*). Then the particular respondent was asked to determine how much she/he would value the environmental improvements of the Buriganga River if confronted with the opportunity to obtain the potential range of goods and services under the specified terms and conditions.

Irrespective of a respondent's decision whether to agree to pay or not for the BRCP, a question was asked whether the respondent would agree to contribute time to the cleanup programme. If they agreed, they were asked the duration of time per month and the manner in which she/he wanted to contribute.

Then questions were also asked for their opinions regarding (i) who else should pay for such development; (ii) who should be responsible for such development initiatives; (iii) what should be the probable duration of payment; (iv) whether they agree with the proposed payment vehicle; and (v) what should be the contribution from different sources (e.g. government exchequer, special fund, donor, non-government organization and private sector).

(iv) Socio-economic and Demographics Information: This section of the survey obtained detailed information regarding the demographic and socio-economic characteristics of the respondents including household income, education, family size, age, employment and marital status and relation with the household head. These characteristics are of interest for a variety of reasons. First, analysis of the demographic characteristics is useful in testing whether the respondent group is representative of the population in the same area. Second, such information from the respondents allows for analyzing how the valuation response varies with demographic and socio-economic characteristics. Third, the replies to these questions permit a detailed social analysis of the community's perceptions and understanding of broad environmental issues. This information, however, was collected only with the consent of the interviewees[19].

4.7 Framing the Valuation Question

The procedures of framing the valuation question are described below.

4.7.1 Willingness to Contribute Question and Elicitation Format

The WTP question mode has several variants and includes dichotomous choice (DC), iterative bidding, open-ended (OE) and payment card. Although dichotomous choice questions have gained popularity over the last several years mainly due to "their purported advantages in avoiding many of the biases known to be inherent in other formats used in the CV survey" (Cameron and Quiggin, 1994: 1), empirical studies on the reliability of this format are still inconclusive. Nevertheless, many favour the referendum or DC format including the NOAA Blue-ribbon Panel for its incentive-compatibility. Cummings *et al.* (1995) argue that the incentive compatibility is "an open empirical question" and back this assertion with evidence that hypothetical responses to referendum questions tend to show systematically greater affirmative responses for some private goods than similar transactions involving real exchanges. The empirical test by Brown *et al.* (1996) also raises doubt on the incentive-compatibility of the referendum format. Comparing the DC format with real decisions, Cummings *et al.* (1995) show that the proportion of hypothetical yes responses exceeds the proportion of real yes responses in case of the three goods (i.e. an electric juice-makers, a calculator and a box of chocolates) they studied.

[19] There were only few cases of refusal where respondents denied to provide age and income information. This was not unexpected in the context of specific cultural and social backgrounds. However, item non-responses do not indicate respondents' any particular behavioural pattern.

Many CV researchers have also investigated whether open-ended or close-ended questions yield more conservative value estimates. Several studies comparing the DC and open-ended payment formats have found that responses to open-ended questions tend to be lower than those to DC questions (Kealy and Turner, 1993; McFadden, 1994; Brown *et al.,* 1996 and Loomis *et al.,* 1996). Comparison of discrete choice and payment card (a variant of the OE format) values shows a similar relationship, with discrete choice estimates exceeding those obtained from payment cards (Ready *et al.,* 1996).

On the other hand, Cameron and Quiggin (1994) reveal that the DC format can be highly statistically inefficient. Kealy and Turner (1993) show that the OE format is a conservative choice and does not generate overbidding. However, Byrnes *et al.* (1999) find that regardless of the payment format, hypothetical values consistently overestimate actual payments. This is in line with other studies (e.g. Lindsey and Knaap, 1999).

One of the major disadvantages of the DC format relative to OE and iterative bidding approaches is that "the DC [dichotomous choice] format does not measure each respondent's maximum willingness to pay (WTP). Instead, it only determines whether the respondent's maximum WTP is larger or smaller than a specified bid amount" (Ready and Hu, 1995: 491). Smith and Mansfield (1998) do not find any significant differences between people's choices with real and hypothetical offers in a field test of CV estimates within a WTA framework.

No consensus seems to exist about the reason for the difference or about which format yields more accurate estimate of actual WTP. Boyle *et al.,* (1996) state that if respondents had well defined preferences for the good, both DC and OE formats should result in similar estimates.

Mitchell and Carson (1989) suggest the payment card as reliable vehicle for a CV survey. Payment card has been used: (i) to estimate economic values of urban forest benefits in Finland (Tyrväinen, 2001); (ii) to measure the economic value of a quasi-public good, the Ste. Genevieve Academy in the USA (Chambers *et al.,* 1998); (iii) to estimate the value of an urban greenway project and to test the validity of CV in Indiana (Lindsey and Knaap, 1999); (iv) to value the flood risk reduction from the construction of a flood control project in the USA (Shabman and Stephenson, 1996); (v) to ascertain the value of reducing the risk of drinking water contamination in Seoul (Kwak and

Russell, 1994); and (vi) to estimate the aggregate benefits of meeting the goals of the Clean Water Act in the USA (Carson and Mitchell, 1993). According to Hoevenagel (1994), it has an advantage in that it provides "stimuli which help respondents to think more clearly about their maximum payment for the goods without pressuring them to give higher WTP values" (p: 205).

The valuation question for this study was constructed using a payment card format according to which respondents were asked to nominate the amount they would be willing to pay. By asking about WTC for the environmental quality improvement, the question encompassed components of both use and non-use values which are not traded in the market, that is, non-marketed, as outlined in the previous chapter. Respondents were first asked whether or not they would be willing to contribute in terms of money. If the respondents answered 'yes' to this question, they were then asked for their maximum WTC_M derived through a payment card. The payment card was selected as the most suitable payment elicitation method, taking into consideration that people were unfamiliar with the notion of a monetary value for environmental goods. This made the process simple and understandable to participants, a significant part of whom are illiterate.

In the FGDs, a bidding game approach appeared to be threatening while in a DC question it was difficult for many to attach a value to resources. An unanchored payment card was adopted where the payment figures ranged from Tk 0 to as high as Tk 2000 and above, based on the pre-testing of the survey instrument. The payment card approach also helped to avoid the pitfalls uncovered by Boyle *et al.* (1985), where the results from sequential bidding experiments are shown to be strongly biased by the starting point. Other studies also show that the initial starting point for the iterative bidding to establish WTP values influence individuals' choice (Regens, 1991). The reason for choosing the referendum format, i.e. it places respondents in a relatively familiar social context (Freeman, 1993), does not hold for Bangladesh as neither referendum nor seeking preference in monetary terms are common practice. Measures were also taken to ensure that respondents kept in mind that their income was limited and must be spread over a range of purchases (see interview schedule in *Appendix VII*).

4.7.2 Follow-up Questions

Follow up questions asked respondents to explain why they answered 'yes' or 'no' to the WTC questions (Portney, 1994). These questions served three functions in the survey. First, they obtained information on the attitudes and values underlying the respondents' valuation response. Second, they provided an indication as to whether respondents considered the valuation problem as had been intended. Third, the explanations offered by respondents revealed the extent of any objection they may hold toward the scenario description, the payment vehicle and the valuation problem generally. In this case, multiple responses were allowed.

The pre-test contained a question after respondents had expressed their WTC_M, which asked them to distribute the value of their WTC_M over the components of the total value. This invitation to clarify how respondents would like their WTC_M to be used has been done in certain previous studies (e.g. Sutherland and Walsh, 1985 and Stevens *et al.,* 1991). The question, however, appeared to be very complex to understand. Considering the general level of knowledge and education of the study's respondents, this question was removed from the final version.

4.7.3 Choice of Payment Vehicle

The payment vehicle is related to the substantive definition of the method of payment. In a number of studies it is found that the payment vehicle affects the elicited values (Rowe *et al.,* 1980 and Greenley *et al.,* 1981). Hoevenagel (1994) suggests choosing the payment vehicle that "fits the environmental change the best and/or the one that will be used if the change is actually implemented" (p: 198). Identifying a reliable and implementable payment vehicle was a challenging task for this survey. Traditionally, payment vehicles used in CV survey are:

- income tax increase (Bennett *et al.,* 1998 and Alvarez-Farizo *et al.,* 1999),
- higher taxes (Bonnieux and Goffe, 1997),
- annual tax and higher product price (Carson and Mitchell, 1993),
- sales tax (Stevens *et al.,* 1995),
- water bill/water-sewer bill (Greenley *et al.,* 1981),
- donation to a trust fund (Brown and Duffield, 1995; Champ *et al.,* 1997; Shechter *et al.,* 1997 and Berrens *et al.,* 2002),
- reduction in take-home pay (Imber *et al.,* 1993),
- surcharge on utility bill (Byrnes *et al.,* 1999),
- special levy (Streever *et al.,* 1998), and
- special one-time tax (Carson *et al.,* 1992).

Several payment vehicles were considered for this study, but none of them seemed to be realistic and credible in the local context. For example, **additional income tax** appeared unrealistic as less than five percent of people are covered by the income tax net in Dhaka City. Less than ten percent of households pay **property tax**. **Entrance fee** to recreation sites and **recreation cost** as payment vehicles were rejected because many survey participants were considered to be potential non-users of a number of the proposed facilities; it also would be physically impossible to exclude users from many of the goods and in most cases entry is free for public recreation facilities. Use of **higher taxes** as the payment vehicle appeared to be inappropriate both at the FGDs and pre-testing as it seemed that people might use the CV question to express general dissatisfaction with tax rates rather than to express a value for the goods. **Sales tax** is not in place in Bangladesh; value added tax (VAT) is in place only on a few commodities. The **donation to a trust fund** as payment vehicle appeared to be unreliable as many believed that the money would be pilfered and misused[20]. This payment vehicle is also potentially subject to free-riding behaviour (Loomis *et al.,* 1996). It was met with a strong opposition both in the FGDs and pre-testing.

Finally, the choice of an **increase in water bill** as a payment vehicle for this survey was selected based on the judgement that it appeared most realistic, credible and implementable during FGDs and pre-testing, mainly because of its suitability with the respondents' high level of familiarity with paying monthly water bills. Currently, residents in Dhaka City pay sewer bills on the basis of their water use. When selecting this payment vehicle, the following problems were kept in mind: (i) a quarter of the households (normally in slums and squatters) did not have water connection; (ii) many families collected water from roadside water-taps (free of charge); and (iii) in many cases, the property owner, rather than the renter, pays water-sewer bills for the rented house. However, there was no need for any adjustment in terms of estimating economic benefits as an earlier survey based on the CVM in Dhaka City revealed that poor slum dwellers were willing to pay for water (Chowdhury, 1999). Recently some NGOs have started to supply water to squatters in Dhaka City at the market rate.

The payment schedule had been set as a monthly payment to facilitate the Buriganga River cleanup programme, its temporal limit of payment was set for ten years and the time respondents would start paying specified as from January, 2002.

20 This is very much in line with existing socio-economic practices in Bangladesh.

4.8 Validity and Reliability

It is important to assess the validity (i.e. does the method measure what it intends to measure) and reliability (i.e. how consistent are these measures) of the CV survey instrument (Cameron and Englin, 1997). It is difficult to assess the validity and reliability of CV estimates because, among other things, "there is no benchmark against which to compare the results" (Imber *et al.,* 1993: 91). Besides, by the nature of the technique, every CV survey is different and subject to different constraints and opportunities. These issues are considered in the context of Bangladesh.

4.8.1 Validity

An instrument is considered valid to the extent it measures what it is supposed to measure, that is, validity measures how accurately the CV of a public good estimates the good's true value to respondents. A fundamental problem arises at this point as the CV instrument aims to measure a value which cannot be identified in the real world because of the hypothetical nature of the scenario and valuation question. Conditions are being defined which are either necessary preconditions for an instrument's validity or appropriate tests of that validity (Hoevenagel, 1994). The guidelines set by the Panel appointed by the National Oceanographic and Atmospheric Administration (NOAA) of the United States Department of Commerce are well-known for achieving valid responses in CV surveys (Arrow *et al.,* 1993). Careful consideration was given to the NOAA Panel's recommendations to achieve valid responses from respondents (which is elaborated later on in Section 4.8.3). Furthermore, to assess the validity of WTC answers, a comparison of the stated WTC_M with the stated income and a set of demographic characteristics is conducted in *Chapter Five*. In addition, a similar comparison of the WTC_T responses with a set of demographic and socio-economic characteristics is done.

4.8.2 Reliability of Responses

Reliability measures the variability among responses; valuations with relatively low variation among responses are considered more reliable estimates of value (Breedlove, 1999). As Hoehn (1990) pointed out "[t]he reliability of the CVM has proven difficult to assess" (p: 105) and only a few researchers have conducted tests of measurement replicability (Georgiou *et al.,* 1997).

In order to test the reliability of the ECV results of the survey, a post survey check approach, a variant of test-retest, was undertaken at a minimal level[21] due to time and budget constraints, following Vaus (1995). As mentioned in Section 4.5, 40 respondents out of total 71 telephone-equipped households were selected randomly and then at a later time (after about four weeks) reinterviewed[22]. After several attempts, thirty-one agreed to talk[23]. They were asked a few questions again including the valuation question (see *Appendix VIII* for full version of the re-interview schedule). This re-interviewing found a high correlation between the respondents' WTC_M in the survey and the post-survey check experiment, indicating that the survey appeared to give a reliable measurement of the ECVM. This is also in line with other studies (see, for example, Georgiou *et al.,* 1997).

In the process of verification, only in three cases out of the total 31 selected re-interviews, were some discrepancies found. For one, I could not find anyone with the given name at the telephone number provided[24]. For two interviews, the answers given over the phone were inconsistent with the answers given in the interview regarding the bid values. In the telephone interview, they opted for higher values. All these discrepancies were adjusted. As a whole, the discrepancies and item non-responses are considered minimal. This was achieved mainly because of the intensive training and close collaboration during the data collection process by checking item non-response regularly.

4.8.3 The National Oceanic and Atmospheric Administration Panel Guidelines

Although the CVM has been used for more than three decades to estimate economic values of non-marketed goods and services, no standard rule exists for examining its validity and reliability. These issues were the subject of heated debate following the Exxon Valdez oil spill in the Gulf of Alaska in 1989. Against the

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[21] Minimal in the sense that only 40 telephone-equipped respondents were interviewed with few questions repeating from the IS and after only four-weeks.

[22] There is a debate whether (i) the same or different respondents should be interviewed; and (ii) after how long, this reinterview should take place (Teisl *et al.,* 1995). Following Vaus (1995), I reinterviewed the same respondents after four weeks using only eight questions including the valuation question.

[23] As mentioned in Section 4.2.1, only the richer class of population has telephones in Bangladesh. Therefore, these 31 respondents may represent neither the survey respondents nor the overall population.

[24] This happened as one (a young girl) of the relatives of that household was visiting them and she was selected for the interview as she mentioned herself as a member of that household. She was also the contact person for that household and she used a false name out of fun. This was corrected later by interviewing another member of that household.

backdrop of the controversy of CV estimates, the National Oceanographic and Atmospheric Administration of the United States Department of Commerce appointed a blue-ribbon panel (hereafter the NOAA Panel) of multidisciplinary experts with two Nobel laureate economists, Kenneth Arrow and Robert Solow as co-chairs in 1992 to assess the reliability and validity in the context of a liability suit[25]. After weighing evidence by both proponents and critics of the method, the NOAA Panel endorsed the use of CVM, with suggestions for the design and implementation of the technique (Arrow *et al.,* 1993). The Panel's recommendations are a set of guidelines for CV survey design, administration and data analysis (Carson *et al.*, 1995a, 1996). The Panel addressed the sources of potential bias inherent in CVM studies and then made recommendations that help to eliminate these sources. Over the years, many CV studies have been conducted following the guidelines of the NOAA Panel[26] (Giraud *et al.,* 1999 and White and Lovett, 1999). The Panel's guidelines are now considered as standard for a CV survey (Smith, 1996 and Navrud and Pruckner, 1997). In the Panel's view, "…the more closely the guidelines are followed, the more reliable the result will be" (Arrow *et al.,* 1993: 4609).

Although the NOAA Panel guidelines are considered as a standard for deriving reliable CV estimates, they have also been subject to criticism, even from the proponents of CV, for their loose recommendations (Randall, 1997). As Navrud and Pruckner (1997) state:

> …the guidelines are not sufficiently strict. On the one hand, the [NOAA Panel] report says that the guidelines should be followed as close as possible. On the other hand, however, it does not provide reference to which deviations would be accepted with the empirical results still remaining valid (p: 12).

There is no standard rule on how far to relax these recommendations, although the Panel suggests that "[i]t is not necessary, however, that every single injunction be completely obeyed; inferences accepted in other contexts are not perfect either" (Arrow *et al.,* 1993: 4610). Lindsey *et al.* (1995) state that "[s]trict adherence to the NOAA guidelines would make use of CV prohibitively expensive for most routine applications" (p: 256). Considering cost and other local conditions, several studies were undertaken relaxing some guidelines of the NOAA Panel[27]. Navrud and Pruckner (1997) also state

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[25] For a background of the NOAA Panel, see Arrow *et al.* (1993) and Portney (1994).

[26] The NOAA Panel guidelines are also being used in *ex post* evaluation of studies (Lindsey *et al.,* 1995).

[27] Relaxation can take many forms, such as, survey administering in a class-room (group) setting rather than in-person (Berrens *et al.,* 1997) and using relatively small sample size, that is, 252 interviews for before scheme survey and 260 interviews for after scheme survey (Tunstall *et al.,* 1999).

that "CV [contingent valuation] surveys for purposes demanding a lower level of accuracy… need not follow all of these guidelines" (p: 23, footnote 6).

The survey instruments and procedures used in this study followed the guidelines recommended by the NOAA Panel, with only a few exceptions which were required due to specific local conditions. A comparison between the NOAA Panel's major recommendations and the survey procedure followed for this study is presented in Table 4.3.

Table 4.3 shows that most of the recommendations made by the NOAA Panel were incorporated in the design of the survey instrument. A few were left out because of local conditions and time and budget constraints. Most importantly, careful consideration was given to keeping the IS, as much as possible, simple, understandable and plausible to the respondents many of whom are not only illiterate, but also economically extremely poor.

Table 4.3: *Comparison between the NOAA Panel guidelines and adopted survey design procedures*

NOAA Panel guidelines	**Adopted survey measures**
General Guidelines:	
a. Sample size and type	a. Reduced size was used*. The NOAA Panel suggests a split sample, but time restrictions did not allow for this.
b. Minimize and explain non-response	b. An 85.10 % response rate was achieved which is considered reasonably good.
c. Personal interview	c. NOAA Panel recommendation was followed (hereafter followed)
d. Pre-testing of interviewer effects & survey instrument	d. Followed
e. Reporting results	e. Followed
f. Careful pre-testing of CV questionnaire	f. Followed
Value Elicitation Surveys:	
a. Conservative design	a. Followed
b. Elicitation format	b. Followed
c. Referendum format	c. Payment card was used**
d. Accurate description of programme/policy	d. Followed
e. Pre-testing of photographs	e. Followed
f. Reminder of undamaged substitute commodities	f. Followed
g. Adequate time lapse from the accident	g. Not applicable
h. Temporal averaging	h. Followed
i. "No answer" option	i. Followed
j. Yes/no follow ups	j. Followed
k. Cross tabulations	k. Followed
l. Checks on understanding and acceptance	l. Followed

Goals for Value Elicitation Surveys:	
a. Alternative expenditure possibilities	a. Followed
b. Deflection of transaction value	b. "Warm-glow" effect was not tested***
c. Steady state or interim losses	c. Followed
d. Present value calculations of interim losses	d. No sensitivity test was conducted
e. Advance approval	e. Not applicable
f. Burden of proof[28]	f. Followed
g. Reliable reference surveys	g. Not applicable

Notes: * Four hundred samples were used instead of 1000 which is recommended by the NOAA Panel (see *Chapter Five* for more information on sample size requirement for normal approximation).

** Although the NOAA Panel recommends dichotomous choice referendum format, payment card was used. The reasons are explained in Section 4.7.1.

*** Reasons are explained in the section to follow.

Source: For NOAA Panel guidelines see Arrow *et al.* (1993).

4.9 Potential Sources of Bias and Remedial Measures

For any survey, examining validity and reliability are considered to be crucial from the point of view of accuracy and credibility. As explained in the previous section, to achieve accuracy and credibility of the survey, the NOAA Panel guidelines are followed with some adjustments for framing, designing, and operation of the survey instrument. In addition, some of the remedial measures considered to correct potential sources of bias related to the design of the ECV survey instrument, which are recognized as very important in the empirical work of the CV survey, are described in this section.

The estimates provided by the CV survey are subject to many types of biases. These are related to both the design of the CV survey (theoretical underpinning of CVM) and the sampling process. The main sources of biases are centered on the hypothetical nature of the CVM approach and are: (i) the very fact that the market is not real (hypothetical bias: Maxwell, 1994 and Hoevenagel, 1994); (ii) the effect of information disclosure on the responses (information bias: Maxwell, 1994); (iii) the format of the survey and questions asked (instrument bias: Maxwell, 1994); (iv) the failure of

[28] The NOAA Panel distinguished a subset of items in their guidelines for special emphasis and described them as the 'burden of proof' requirements. These are "(i) a high non-response rate to the entire survey or to the valuation question, (ii) inadequate responsiveness to the scope of the environmental insult, (iii) lack of understanding of the task by the respondents, (iv) lack of belief in the full restoration scenario, and (v) 'yes' or 'no' votes on the hypothetical referendum that are not followed up or explained by making reference to the cost and/or the value of the program" (Arrow *et al.,* 1993: 4609). These requirements were also fulfilled in the survey design.

respondents to take into account external financial constraints (mental account bias: Schkade and Payne, 1994); (v) the purchase of moral satisfaction (warm glow effect: Kahneman and Knetsch, 1992); (vi) the estimate being derived from a sample rather than a complete enumeration (sample selection bias) and others.

However, as Vaus (1995) points out, "the difficulty is not so much the bias itself, but in working out what the bias is and to what extent it occurs" (p: 73). Once these are known, suitable remedial measures can be made. Thus, careful survey design can control these sources of biases. A brief description of the potential biases expected in the survey as outlined in the literature[29] and the survey design strategies employed to minimise this type of errors for this study are discussed below.

Hypothetical Bias: Hypothetical bias, caused by the hypothetical nature of the CV market[30], could mean that respondents' answers are meaningless if their declared intentions cannot be taken as an accurate guide to their actual behaviour. This is most likely to occur if respondents are very unfamiliar with the scenario presented to them. In Bangladesh, although preference elicitation through household survey is not a usual practice, most respondents are aware of the magnitude of the problem being studied. Also, a carefully designed, worded and believable description of the goods and services, after adequate pre-testing, was presented to the respondent.

Information Bias: This bias can occur due to the inability of a respondent to completely visualize all changes connected with the proposed programme. The design of the question and additional information that is provided may influence the stated WTC. This leads to a dilemma: with too little information, the respondents are unable to make informed decisions; and providing too much information influences the respondents, depending on how and what information is provided. Although many disagree with the notion of information bias, as Seroa da Motta (2001) states "[i]nformation should influence WTP in exactly the same way as information influences WTP in the everyday market place for ordinary goods" (p: 57). While the issue of how much information should be provided on the constructed market is still inconclusive, I follow Seroa da Motta's (2001) view that "what matters most is that the same level of

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29 The extent and nature of such biases are described in detail in Mitchell and Carson (1989) and Imber *et al.* (1993).

30 The substance of most criticism directed at the CV is that it provides hypothetical answers to hypothetical questions (Diamond and Hausman, 1993). The empirical evidence is inconclusive as to whether people make the same kind of valuation decision when they are asked to pay in reality. Byrnes *et al.* (1999) indicate that hypothetical WTP is a poor predictor of actual WTP.

information be provided to all respondents" (p: 57). This was followed during the interviews and only information contained in the IS was provided.

Strategic Bias: Strategic bias exists when respondents refuse to reveal their true WTC as a result of strategic thinking, that is, they may understate the true value of their preference in the expectation that they will be able to enjoy the goods while others are paying (i.e. the free-rider problem) or they may overstate their preference to see the goods provided. Seroa da Motta (2001) states that "[t]ests for strategic bias suggest that, contrary to expectation, it may not be of major significance" (p: 57). For this study, strategic bias is not expected to be a major problem as respondents were informed that this study had no policy relevance.

Starting Point Bias: Mitchell and Carson (1989) find that the "initial amount suggested by the interviewer often influenced respondents' answers because they tended to base their answers on this amount instead of making an independent determination of what the water quality improvements [proposed changes] were worth to them" (p: 7). Each elicitation technique has its unique characteristics which makes its application in certain cultures more suitable. Many studies have explored the effectiveness of alternative valuation mechanisms in avoiding a starting point bias[31]. Payment card, on which a wide range of dollar values is listed, is one of the choices of payment vehicle to avoid starting point bias. A range of amounts was chosen through interviews, FGDs and pre-testing for this study as explained earlier. Cummings *et al.* (1986) pointed that "[i]n the case of the payment card, the choice of a starting bid is left up to the subject in that the subject chooses his/her 'starting point' from the values given on the payment card" (p: 29). Combined with a face-to-face interview, the use of the payment card is expected to minimize the likelihood of respondents being influenced by the starting point.

Embedding Problems: Embedding or part-whole bias arises from the potential weakness of the respondents in valuing one part of an environmental good. Bateman *et al.* (1997) describe part-whole bias as: "if the component parts of a whole are evaluated separately, the sum of those valuations tend to exceed the valuation placed on the whole" (p: 322). The CV critics often argue that the lack of sensitivity to scope or embedding results from 'warm-glow', that is, getting moral satisfaction from the act of paying for the good independent of the characteristics of the actual goods (Kahneman and Knetsch, 1992). Eliciting WTC preference may provide the opportunity for respondents to state their general preference towards the environment rather than for the specific goods in question (e.g. water quality improvement). The value revealed may create the 'warm-glow' of contributing to save the wider environment rather than the specific service in question. While some empirical evidence shows insensitivity to the scope of the good being valued (Boyle *et al.,* 1994), other examples show substantial sensitivity to the good's scope (Smith and Osborne, 1996). In this study, to reduce the 'warm-glow' effect from overstating the WTC and following Hadker *et al.* (1997), it was made clear in the IS that it was alright if the respondent chose not to be willing to contribute either cash or time.

Embedding effects could have been tested by adding a question on whether respondents would be willing to donate an additional sum for the rivers (other than the Buriganga) surrounding Dhaka City and, if not, whether they would be willing to divide the committed amount of contribution between the Buriganga River and one or more rivers. However, for this study, it is not only a single problem of the Buriganga River (e.g. pollution and encroachment), but rather the idea of developing a set of environmental goods and services linking with the cleanup of the Buriganga River that has been designed. The constructed market on the Buriganga River is in many ways a unique resource. Its landscape, ecology and many of the recreational facilities expected to be generated by the cleanup programme have no adequate substitute. This means the confusion of part and whole described by Kahneman and Knetsch (1992) is less likely to be a problem; in effect the part and the whole are the same. Besides, embedding or part-whole effect were dealt with by helping the respondent place the good in question (i.e. the Buriganga River cleanup programme) in context. Several contexts were explicitly stated: the household budget constraint, competing uses of incomes, other environmental problems the city faces and other environmental or priority areas of concerns the respondent may have. Consequently, embedding or part-whole bias is not expected to be a major problem.

Interviewer Bias: Interviewers were carefully selected and trained in the survey techniques. They worked in collaboration with me and under my direct supervision. A test for potential biases, comparing survey results among interviewers, was not considered meaningful as some variation was expected because of the socio-economic

[31] Empirical evidence suggests that the 'seed value' or starting point influences WTP values (Streever *et al.,* 1998 and Schulze *et al.,* 1981).

differences within the study area. Due to the extensive training and motivation, it is expected that the interviewer bias was minimal.

Payment Vehicle Bias: Payment vehicle bias occurs when the answers vary with the mode of payment. Cummings *et al.* (1986) argued that respondents with an aversion to higher taxes might understate their willingness to pay for an environmental amenity if such payment must be made through higher taxes. They found that the choice of payment vehicle would seem to be an important determinant of values derived with the CV method. However, avoiding payment vehicle bias is not possible; as Wilks (1990) comments "[b]ias only exists if the researcher fails to acknowledge the effect of the choice of payment vehicle on the respondents' willingness to pay. For some valuation problems it will be difficult to eliminate payment vehicle bias where there are few or no alternative plausible payment vehicles to choose from" (p: 28). As explained earlier, choosing a plausible payment vehicle was very difficult for this study. After careful consideration, an increase in the water bill was chosen as payment vehicle for this study which appears credible as well as easily implementable in Dhaka City.

Sample Selection Bias: The benefit estimates can become biased as a result of sampling decisions and procedures at any or all of the stages of the survey operation. A potential non-response bias was not expected to be a problem as due emphasis was given on systematic procedures for selecting probability samples from the population. A comparison of the demographic and socio-economic characteristics of respondents and non-respondents showed little difference between them.

Non-responses were not related to the subject matter of the survey. Respondents in general showed strong support for this survey. The failure to interview some people who were not found at home or who refused to be interviewed had nothing to do with their personal reaction to the survey's topic. Those who refused to be interviewed in the survey did so before the specific topic of the survey was disclosed. The interview topic, particularly the WTC question, was not disclosed when the respondents' cooperation was first sought to avoid this type of bias. Refusals occurred because of general rather than survey-specific reasons.

Out of a total of 33 refusals (either refused to participate in the survey or to be interviewed[32]), 17 agreed to explain the reasons for their decision. Among them, three contact persons did not allow the selected respondents to talk to the interviewer as the

[32] For detail description, see *Appendix VI*.

potential survey participants were women (they insisted on being interviewed instead of the female member of their household selected for the interview)[33]. Nine said that they would not talk with an unknown person (interviewer), two reasoned lack of time, one mentioned lack of any financial incentive for being interviewed and two stated they did not believe in such surveys. Ten potential respondents were not possible to contact after three visits.

A total of 16 households could not be contacted in any way. Among those, six were in the 'posh' Gulshan thana where it was not possible to reach any members of the household owing to the problems of overcoming security measures at the front gate. For the remaining, after several requests, no members of the household were contacted. The simple reason they communicated through servants, caretakers or security guards was that they were not interested or were busy. The deteriorating law and order situation prevalent at that time in Dhaka City could have contributed to such an attitude.

To minimize the non-sampling error and following Imber *et al.* (1993), careful consideration was paid to the design and testing of IS, field procedures testing, preparation of field documentation and training of interviewers, clear IS layout, pre-coding of question options, range and consistency editing, and supervision and auditing at all stages. Considerable attention was given to reducing the non-sample error throughout the survey administration cycle. Item non-response was minimal because of conducting the interview in-person and the repeated emphasis put on interviewers to be aware of these in the interviewing process.

Although potential biases are very important consideration for CV surveys, the careful remedial measures adopted in this study were able to control them to some extent.

4.10 Data Analysis and Selection of Test Statistics

Data and information were collected for this study from various sources using a variety of methods. The ultimate objective is to put these data and information into the cash flow of an extended cost-benefit analysis which is done in *Chapter Six*. As far as the survey is concerned, it aims to generate an estimate of benefits of non-market goods.

[33] Part of the problem was that the interviewer responsible for that area was male. It was not possible to make an arrangement to send a female interviewer for those potential respondents due to time constraint and remoteness of the locality from the place of the survey operation.

To analyze the data generated from the survey, both descriptive and inferential statistics are used. Hence, the selection of test statistics is important.

The selection of test statistics is undertaken considering two criteria: (i) what are the purposes or objectives of the statistical analysis; and (ii) what types of data are to be analyzed. The main purpose in this study, as already stated, is to estimate an aggregate WTC value to be used for the ECBA. The level of measurement is categorical, i.e. most variables are measured on a nominal scale. Therefore, the scaling of the variables makes the parametric tests (e.g. z test, t test and F test) inappropriate, as Grimm (1993) states "if the data are based on a nominal scale, there is no alternative; a non-parametric test must be used" (p: 431).

The research question is invariably about the characteristics of the population (parameters), not those of a sample (statistics). It is in this context that the need for statistical inference arises which purpose is to draw conclusions about the wider population from the sample data. Two types of statistical inferences are used: *confidence intervals* for estimating the value of a population parameter; and *test of significance* (hypothesis testing) to assess the evidence provided by the data in favour of a certain claim about the population. Both types of inference are based on the sampling distributions of statistics, i.e. "both report probabilities that state *what would happen if we used the inference method many times*" (Moore and McCabe, 1999: 434; emphasis original).

Hypothesis tests are used to establish relationship between WTC and other variables. Hypotheses are established that relationships do not exist (i.e. willingness to contribute is independent of the variable in question) and such a hypothesis is accepted or rejected using Pearson's chi-square test (χ^2). To test the significance, two types of chi-square tests are used: (i) chi-square test for *goodness-of-fit* is applied to the analysis of a single categorical variable; and (ii) chi-square test for *independence* is applied to the analysis of the relationship between two categorical variables. For chi-square tests five percent critical value (χ_α) is commonly used. These tests are generally based on the probability of saying yes or no to the valuation question.

Chi-square tests of goodness-of-fit and of independence are executed using the following test statistic:

$$\chi^2 = \sum_{\text{All cells}} \frac{(f_e - f_o)^2}{f_o} \tag{4.1}$$

where f_e and f_o represent observed and expected (theoretical) frequencies of the distribution. The decision rule for this test statistic is: reject the null hypothesis that the discrepancy between the observed and theoretical frequency distribution is due to chance if the obtained value of $\chi^2 \geq \chi_\alpha^2$; otherwise, retain the null hypothesis. The degree of freedom for the goodness-of-fit test is the number of columns (categories) in the design minus one. The degrees of freedom associated with an independence test is the number of rows in the contingency table minus one, multiplied by the number of columns in the table minus one.

The chi-square statistical test is not without its own assumptions and restrictions. One important difference between the chi-square test and the parametric test is that the chi-square test makes no assumptions about population parameters or population characteristics for its use (Grimm, 1993). Non-parametric tests also have fewer assumptions about population characteristics. A basic assumption in using chi-square is that there is independence between each observation recorded in the contingency table. This assumption is maintained by ensuring that each subject has only one entry in the table. The second assumption is that the sample size must be large enough so that the expected frequency in each cell is at least 5 for tables where the number of rows or columns is greater than two. If the table is a 1 x 2 or 2 x 2, then each expected frequency should be at least ten (Pagano, 2001). This assumption is also maintained.

For summarising the data, use is made of contingency tables, bar charts, histograms and other graphic representations. *Summary statistics,* such as means and medians, are also used to calculate estimates of the total benefits for the cleanup programme. A valuation frequency distribution is used to estimate the proportion of the target population that is willing to contribute the stated amount for the cleanup programme.

4.11 Conclusion

In this chapter, various methods adopted to collect data and information, such as case study, survey, use of secondary sources, benefit transfer, direct observation and focus group discussion are described. Particular attention is given to the survey procedures. The survey instrument is outlined based on a scenario designed for an ECVM exercise intended to estimate the non-market benefits of the Buriganga River cleanup programme. In designing the measurement instrument, the IS is made as realistic as possible using conservative wording with adequate FGDs and pre-testing as well as adopting a plausible elicitation format taking into account the local context. Different types of potential biases associated with the measurement instrument are described and their remedial measures are also outlined to ensure the accuracy and precision of the data. The recommendations of the NOAA Panel are taken as a guiding framework with some exceptions due to contextual differences in designing and administering the survey to achieve valid and reliable responses.

The descriptive and inferential statistics to be used to analyze the survey data are also elaborated. On the basis of the methods and procedures described in this chapter, the survey data is analyzed to estimate the non-market benefit of the BRCP in *Chapter Five*, and market data (using secondary sources and benefit transfer approach) are analyzed to estimate market benefits of the BRCP in *Chapter Six*. These estimates are used in the extended cost-benefit analysis in *Chapter Six*.

Alam, Khorshed. (2003). *Cleanup of the Buriganga River : integrating the environment into decision making*. PhD Dissertation. Perth, Murdoch University.

Chapter Five

MEASURING NON-MARKET BENEFITS OF THE BURIGANGA RIVER CLEANUP PROGRAMME

5.0 Introduction

The theories and methods for estimating the different components of the TEV were identified in the previous chapters. The components of the TEV, described in *Chapter Three*, suggest that both survey and market data are required for an estimation of the TEV of the BRCP; non-market benefits are measured through an ECV survey, and market benefits are estimated using market and secondary data. A survey method for measuring the non-market benefits was also elaborated in *Chapter Four*. The survey is designed to elicit non-market benefits of the total value of the BRCP independent of the market benefits. This chapter aims to estimate the non-market benefits of the BRCP using the ECV survey output. A WTC value for the participants of the ECV survey is derived and inferred for the residents of Dhaka City. This value constitutes the core of the TEV which is used, along with the value of market benefits, in the next chapter to conduct an extended cost-benefit analysis (ECBA) for the BRCP.

The chapter is divided into ten sections. Section 5.1 is concerned with statistics providing description of survey participants' knowledge, belief and opinion about environmental problems in Dhaka City and the Buriganga River. Section 5.2 estimates some population parameters (e.g. proportion of yes-saying participants willing to contribute both money and time) and then the total willingness to contribute of the residents of Dhaka City for the BRCP. A comparison of some demographic characteristics between the survey sample and Dhaka City population is presented in Section 5.3. Section 5.4 examines associations among variables. How the WTC_M responses are related to other demographic characteristics of the respondents is also discussed in this section. Section 5.5 and Section 5.6 elaborate on the issue of validity and reliability of WTC_M responses respectively. Section 5.7 presents the analysis of the relationships between respondents' socio-economic and demographic characteristics and their WTC_T. Section 5.8 assesses the validity and reliability of WTC_T responses.

Section 5.9 presents a description of the socio-economic and demographic characteristics of respondents willing to contribute both money and time. Section 5.10 concludes the chapter.

5.1 Descriptive Statistics

During the ECV survey, questions were asked which reflect respondents' knowledge, attitudes, expectation and opinion related to the environmental problems in Dhaka City and the state of the Buriganga River. The responses are analyzed using mostly frequency and contingency tables. The purpose is to provide insights as to the general knowledge and attitude in relation to the Buriganga River. The distributions of values for each variable of interest are presented below.

5.1.1 General Features of Respondents

A random sample of 400 households in Dhaka City were interviewed. These interviews took place in the respondents' houses or nearby premises. The places of interview are shown in Table 5.1.

Table 5.1: *Places of interview*

Place	% of total response
Drawing room	50.00
At the door	33.75
Street	5.75
Dining space	4.50
Bedroom	4.25
Veranda	1.75
Total	100.00

Source: ECV survey

Half of the interviews (50 percent) took place in the drawing (lounge or sitting) room of respondents, about 4.25 percent in the bedroom (some one-room houses were interviewed in the shanties and slums and these places of interview are considered as bedroom), and 1.75 percent in the veranda. Many interviews took place at doors (33.75 percent) and some even occurred in the street (5.75 percent).

The sample consists of 58.25 percent of men (233) and 41.75 percent of women (167). The mean age of the respondents is 39 years and the median age is 30.56 years. The average number of people living in the responding households is just over five.

Respondents were asked about the duration of their residence in Dhaka City (see Table 5.2). More than half of the respondents have lived in Dhaka City for more than ten years. One fifth have lived for less than five years. This is not surprising for a developing city and is consistent with the overall demographic pattern.

Table 5.2: *Respondents' duration of residence in Dhaka City*

Duration	**Responses**	**Percent**
Less than 5 years	80	20.00
6 – 10 years	101	25.25
11 – 15 years	58	14.50
16 – 20 years	72	18.00
20 – 30 years	53	13.25
More than 30 years	36	9.00
Total	400	100.00

Source: ECV survey

Among the respondents, 70.75 percent are employed and approximately 29.25 percent are unemployed (21 percent do not work and 8.25 percent are currently looking for job). Among the employed, about a third of the respondents' occupation is household work (31.10 percent) followed by service (18.73 percent) (see Table 5.3). Only a few people (less than one percent) are involved with agriculture.

Table 5.3: *Respondents' occupation*

Occupation	**Responses**	**Percent**
Household work	88	31.10
Service	53	18.73
Others	50	17.67
Business	49	17.31
Transport and communication	21	7.42
Industry	13	4.59
Construction	8	2.83
Agriculture	1	0.35
Total	283	100.00

Source: ECV survey

5.1.2 Knowledge about the Surrounding Rivers

A question on knowledge about the rivers surrounding Dhaka City was asked. It required respondents to name the six rivers surrounding the city (see Table 5.4). Only 1.75 percent (seven) could tell the name of all six rivers. About 76 percent (203) could

Table 5.4: *Familiarity with the names of surrounding rivers*

Names of rivers known	**Responses**	**Percent**
All six rivers	7	1.75
Five rivers	18	4.5
Four rivers	38	9.5
Three rivers	83	20.75
Two rivers	81	20.25
At least one river	139	34.75

Can't remember name of any river	34	8.75
Total	400	100.00

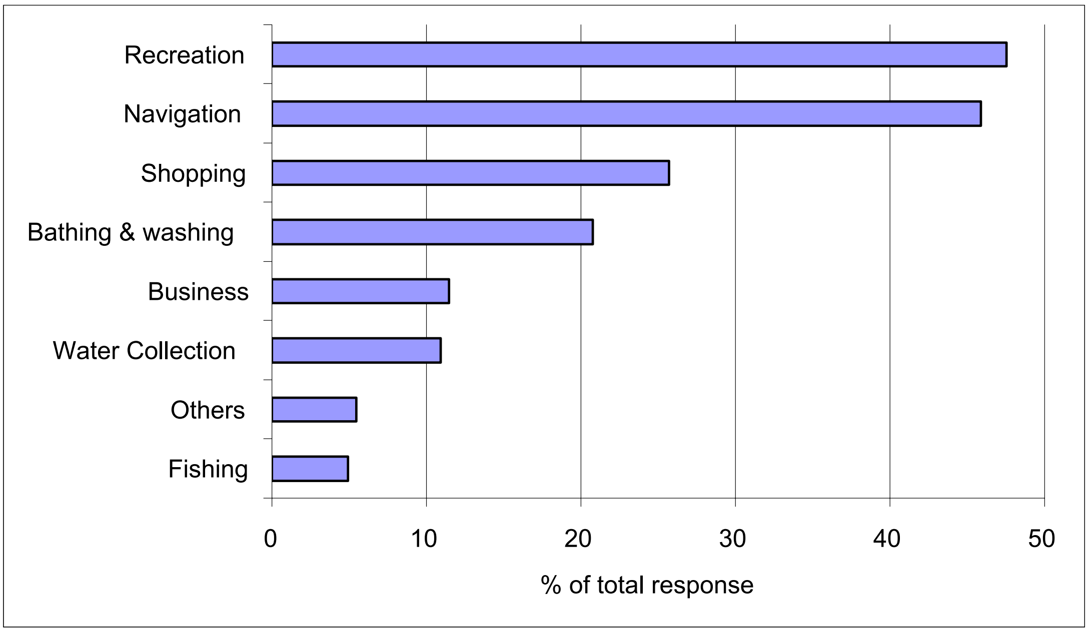
Source: ECV survey

tell the name of up to three rivers. About 8.75 percent (34) could not tell the name of any river. Over 88 percent (354) could tell the name of the Buriganga River which shows that this is the most popular and well known river in Dhaka.

5.1.3 Visits to the Buriganga River

Respondents were asked whether or not they had visited the river during the last three years. Around 45.75 percent of them (183) had visited the river at least once in the last three years preceding the survey, about 52 percent (208) had never visited the river and 2.25 (9) percent could not remember. The high number of respondents who have never visited the river might be due to the large study area (about 360 sq km), high level of pollution and closure of many recreational sites in and around the Buriganga River. Respondents were also asked to specify reasons for such visits (see Figure 5.1). The most popular (non-exclusive) reasons for visiting the river are recreation (47.50 percent) and navigation (45.90 percent). It is interesting to note that despite the high level of pollution and overall deterioration of the surrounding environment, the Buriganga River is still one of the major sources of recreation to the residents of Dhaka City. Although the city is surrounded by six rivers, the Buriganga is considered to be the main source of recreation, particularly water-related. Many historical sites and places of interest are located on the bank of the Buriganga River. Another surprising outcome is that about 4.92 percent respondent visit the river for fishing (both commercial and recreational).

Figure 5.1: *Uses of the Buriganga River*



Note: Percentage total does not add up to 100 as multiple answers were allowed.

Commercial fishing, however, in the Buriganga River is only available in the rainy season when the level of pollution is low due to dilution and fish can move from both upstream and downstream waters.

Many residents use other surrounding rivers while using the Buriganga River as these rivers are interconnected. During the field visit to the Buriganga River, I encountered a fisherman (who described himself as a commercial fisherman). After spending four hours fishing, he had caught about half a kilogram of *tilapia* for which the market price would be about Tk 20. Certainly, such fishing is not a viable option in terms of opportunity cost of labour. Even then, many people engage in fishing because of disguised family labour[1].

Many *hats* and *bazaars* (both legal and illegal) have been developed on the bank of the river. About 25.68 percent of the respondents visit the river for shopping. About 20.77 percent visit the river for bathing and washing. Despite the severe water pollution, many people use the river for bathing. Due to lack of water supply from the DWASA, many slum dwellers who live on the bank of the river do not have any alternative but to use it for bathing and washing.

5.1.4 Potential Uses of Facilities

The respondents were asked to indicate the choices they would make if some facilities were restored or developed in and around the river. The options included both use and non-use factors. When questioned about which of the eight facilities they would prefer to use if developed or restored, the most preferred responses (non-exclusive) were water transport (84.5 percent), use of access road (74.8 percent) and jogging and walking (63.8 percent) (see Figure 5.2)[2].

5.1.5 Environmental Concerns about the Buriganga River

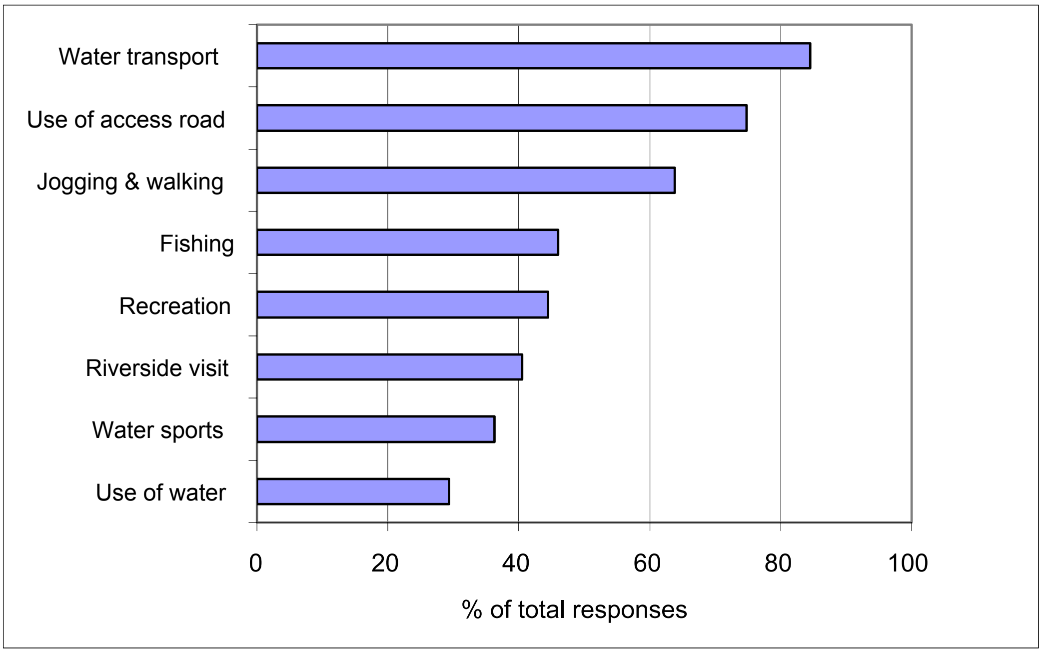
In total, a relatively high 67.75 percent of the survey participants had an adequate knowledge of the current environmental threats to the Buriganga River which made them concerned about the state of the river. Nevertheless, one in three people (about 33 percent) was not concerned which is a worrying finding in the context of the high pollution. The issues of concern belong to a variety of categories (see Figure 5.3),

[1] This is the surplus labour within a family, whose marginal productivity is almost zero.

[2] Percentage total does not add up to 100 as multiple answers were allowed.

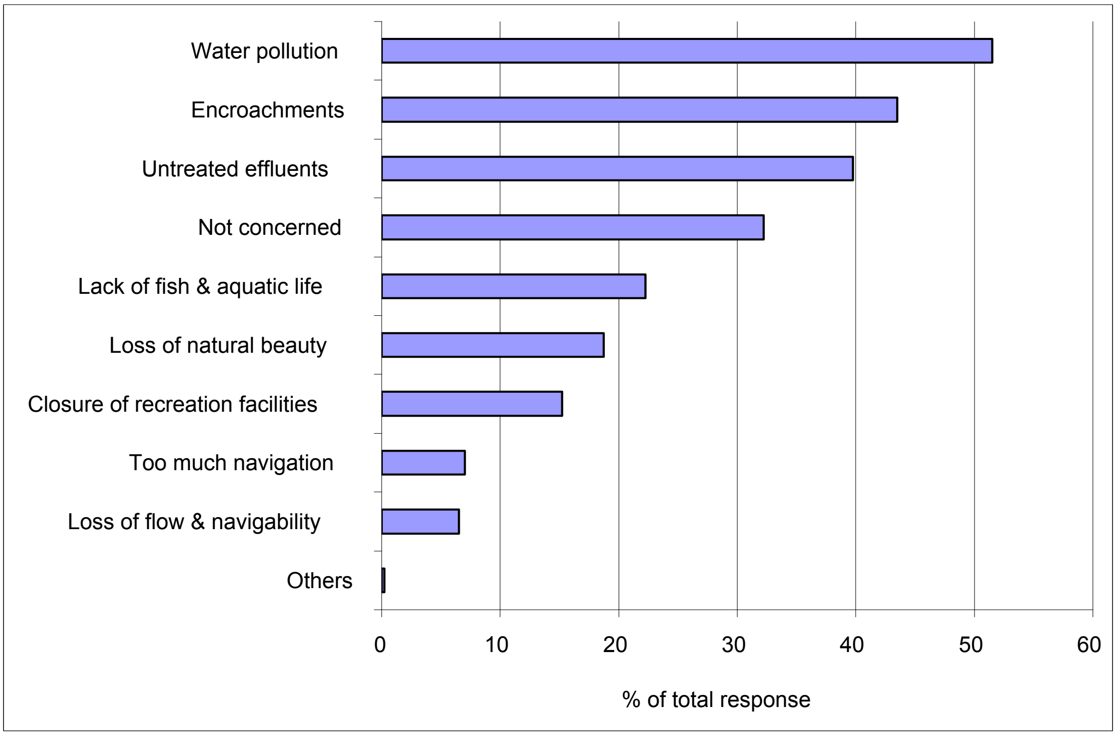
such as water pollution (51.5 percent), encroachments (43.5 percent), untreated effluents (39.75 percent), lack of fish and aquatic life (22.25 percent), loss of natural beauty (18.75 percent), closure of entertainment facilities (15.25 percent), too much navigation (7 percent) and loss of flow and navigability (6.5 percent)[3].

***Figure 5.2:** Potential uses of facilities*



Note: Percentage total does not add up to 100 as multiple answers were allowed.

***Figure 5.3:** Environmental concerns about the Buriganga River*



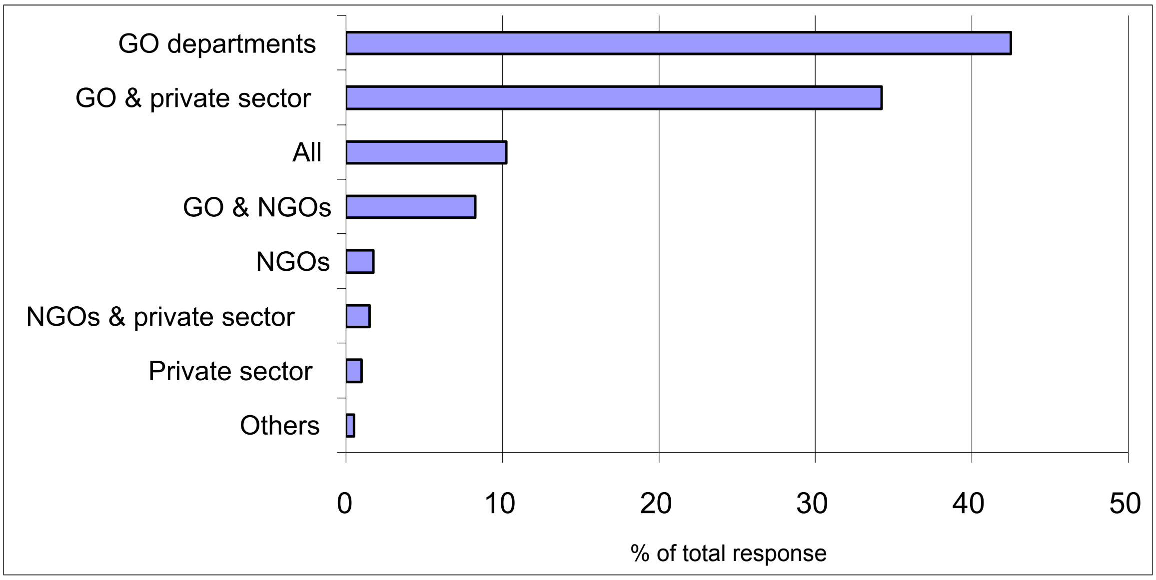
Note: Percentage total does not add up to 100 as multiple answers were allowed.

[3] Percentage total does not add up to 100 as multiple answers were allowed.

5.1.6 Institutions Most Suited to Implement the Programme

Traditionally public agencies are involved with the type of activities required for the BRCP in Bangladesh. A question was posed to all respondents, regardless of whether or not they support the proposed BRCP or would be willing to contribute money, time or both, who should be involved with the implementation of the BRCP. The organizations which could implement such a cleanup programme are listed in the eight categories shown in Figure 5.4. The majority of the respondents thought that it was the sole responsibility of the government (GO) departments to undertake such a programme. About 85 percent thought that government should be involved in one way or other (i.e. along with the private sector or NGOs), including 34 percent who want to see the government act together with the private sector.

Figure 5.4: *Institutions most suited to implement the programme*



5.1.7 Support for the Buriganga River Cleanup Programme

For many reasons, the health of the Buriganga River has become an issue of concern and there has been increased interest by the public for interventions to stop pollution and prevent other problems. This was reflected in the survey. During the period of the survey, a momentum of high enthusiasm was observed. Out of four hundred surveyed respondents, 378 (94.50 percent) supported the BRCP. Ten respondents (2.50 percent) did not support the BRCP and twelve (3 percent) could not make any decision about whether they would support it or not. This overwhelming support shows the need for urgent actions to be taken to improve the situation with the river.

5.2 Estimates of the Residents' Contribution

The primary goal of the ECV survey is to estimate residents' WTC and this is covered in the following section. The WTC value is estimated in a two-stage framework designed to elicit respondents' preferences on the basis of the theoretical construct developed in *Chapter Three* – the two stages being willingness to contribute money (WTC_M) and willingness to contribute time (WTC_T). The estimates are presented below.

5.2.1 Estimate of the Willingness to Contribute Money

Table 5.5 shows the number of participants willing to contribute money (WTC_M) for the BRCP. The sample proportion of respondents willing to contribute for the BRCP is (102/400 =) 0.255, or 25.50 percent of the households which is quite a significant outcome.

Table 5.5: *Willingness to contribute money for the cleanup programme*

	Observed counts	Percent
Yes	102	25.5
No	298	74.5
Total	400	100.0

Source: ECV survey.

The standard error of the sample proportion is 0.0218 and estimated variance of the sample proportion is 0.0005. The 95% confidence interval for the population proportion of yes-saying to WTC_M is 0.2123 to 0.2977. This means that between 21.23 and 29.77 percent of the households in Dhaka City are willing to contribute money for the BRCP. This estimate is legitimate as both the lower and upper endpoints of the confidence interval are greater than five[4]. For any further analysis, it is assumed that 25.50 percent of the residents of Dhaka City are willing to contribute money for the BRCP.

The unknown population proportion is estimated by the sample proportion. If the sample size is sufficiently large, the sample proportion has approximately normal distribution (Moore and McCabe, 1999). A question may be raised legitimately: 'how large must the sample size be'? The answer largely depends on the size of the

[4] Estimating the population proportion using the normal distribution is only legitimate when there is a reasonably sized sample and when the population proportion is neither too close to 0 nor 1 by both the lower and upper endpoints of the confidence interval. A rule of thumb often used to check these requirements is that both np and n(1-p) are greater than 5, where n and p are sample size and population proportion respectively (Ramsey and Schafer, 1996). By checking the endpoints of the confidence interval for sample size requirements, it is ensured that np and n(1-p) for both endpoints are greater than five.

proportion. Ramsey and Schafer (1996) state that "[i]f π [proportion] is near one-half, the sampling distribution is nearly normal for sample size as low as 5 to 10. If π [proportion] is extremely close to one or zero, a sample size of 100 may not be adequate" (p: 521). Mitchell and Carson (1989) suggest that, based on a simple statistical tolerance formula, sample sizes between 200 and 2500 are probably appropriate. Therefore, a sample size of 400 as used in this study is generally considered to be appropriate for normal approximation.

From the sample of 400 respondents, 25.5 percent are willing to contribute money for the BRCP to save the river. Pearson's Chi-square (χ^2) goodness-of-fit is used to assess the difference between yes-saying and no-saying according to the model of equal responses in order to test the significance of whether this sample proportion is due to a chance variation (see Table 5.6).

***Table 5.6:** Chi-square for willingness to contribute money*

	Observed counts	**Expected counts**
Yes	102	200
No	298	200
Total	400	
χ^2 = 96.04; df = 1; P < 0.001		

Source: ECV survey.

The critical value of χ^2 is 3.84 for one degree of freedom (df) at the 5 percent level of significance[5]. The obtained value of χ^2 is 96.04 which is greater than the critical value. Hence, the null hypothesis is rejected and there is a difference between yes-saying and no-saying responses.

The estimated proportion of the population willing to contribute money for the BRCP is 25.5 percent. Their contributions can vary between very small and large amounts. Table 5.7 below shows the distribution of actual monetary amounts that the respondents are willing to contribute.

Out of 400, 99 respondents have chosen an amount (see Table 5.7), although 102 respondents initially agreed to pay for the BRCP. When the question to select an

[5] The value of level of significance (α) most commonly used by social researchers is 0.05 (Sarantakos, 1998). In such cases, it is accepted that there is a five percent probability of rejecting a true null hypothesis. An alternative way of saying this is that, if it were to randomly take a number of samples from the same population, a difference as great as that at the 0.05 level would occur by chance in only one in twenty samples. Throughout this chapter, a 0.05 level of significance is maintained, unless otherwise specified.

amount from the payment card was introduced in the survey, three respondents could not make any decision which amount to choose.

The mean monthly amount of the WTC_M is (Tk 14,374/99 =) Tk 145.19 and the median monthly amount of the WTC_M is Tk 51.91.

Table 5.7: *Distribution of willingness to contribute money*

Monthly amount (X)	Midpoints (x)	Frequency (f)	Cumulative frequency (cf)
> Tk 2000	3000	3	3
Tk 1001 – 2000	1500.5	0	3
Tk 501 – 1000	750.5	2	5
Tk 201 – 500	250.5	10	15
Tk101 – 200	150.5	8	23
Tk 51 – 100	75.5	27	50
Tk 1 – 50	26	49	99
		n=99	

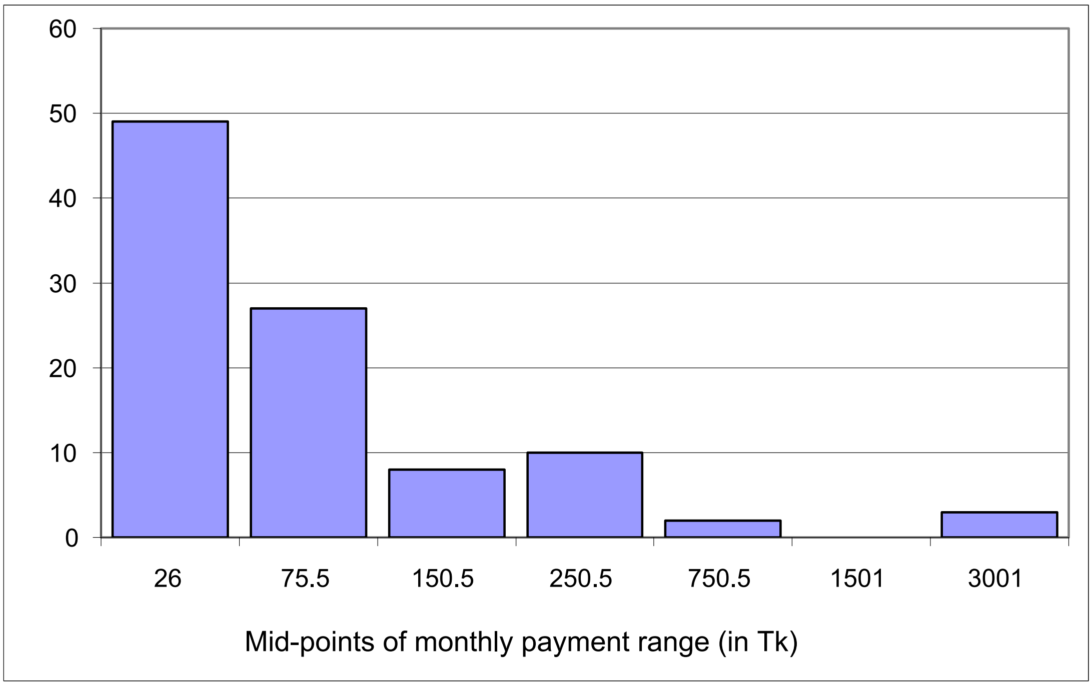
Source: ECV survey.

The CV literature has long recognized the problem created by the extreme values, i.e. outliers. A visual inspection of Figure 5.5 shows that the distribution of WTC_M responses is skewed towards the lower money values. Three observations fall away from the bulk of the sample which has therefore affected the mean of the WTC_M. Another aspect is that the WTC_M result is somewhat bimodal in nature. Although the mean makes full use of the data available, the flip side of this is that it can be greatly affected by outliers; as such the mean is said to be a non-resistant measure.

There has been considerable debate concerning the issue of whether the mean or median WTC_M should be chosen as the appropriate welfare measure. Imber *et al.* (1993) argue that "while the mean may be logically correct for use in benefit estimation for benefit-cost analysis, the median is the preferred measure in practice. This is a conservative approach in terms of willingness to pay estimation because the mean will generally be larger than the median…" (p: 83). If the median is used, it is not affected by extreme values.

For measuring the WTC_M amount in this study, the median is chosen rather than the mean because it is closer in value to more of the observations and is resistant to both outliers and skewness (in such a situation the mean and median can be quite different which is observed above). Another reason behind choosing the median, rather than the mean, is that one of the class intervals in the data is open-ended – that means its upper limit can be defined only arbitrarily.

Figure 5.5: *Distribution of willingness to contribute money responses*

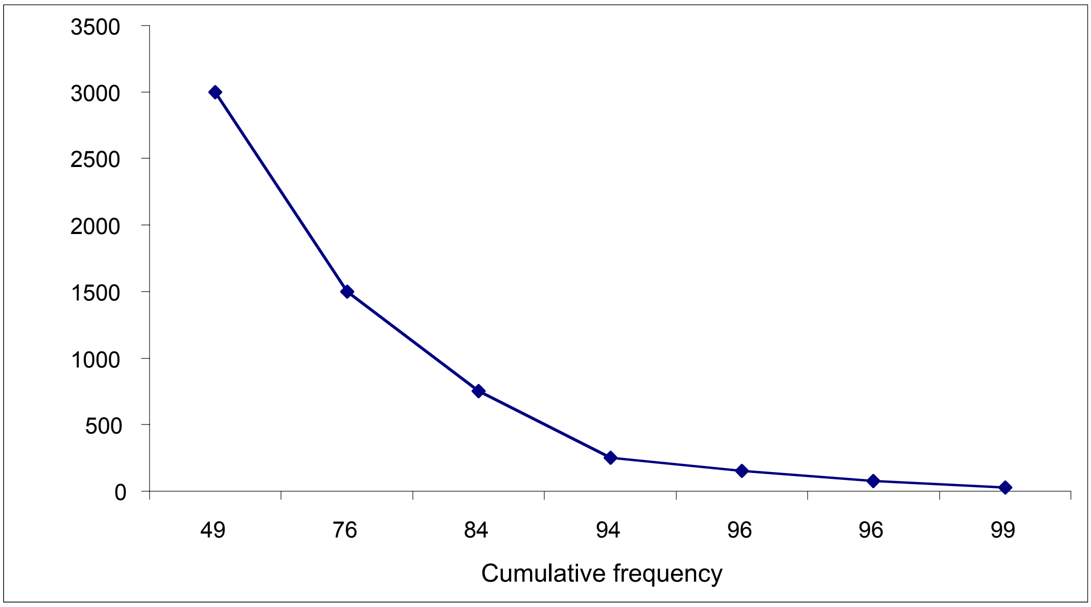


The median of Tk 51.91 is a relatively small sum and is just above the lowest bracket of the payment card. Interestingly, 49 percent of the respondents indicated the lowest category (between Tk 1 and 50) in the survey as the amount they are willing to contribute for the BRCP. The median value reflects the bulk of the observations. As such, it is a better estimator than the mean and the confidence interval for averaging WTC_M. This median value will be used as average WTC_M value for the residents of Dhaka City[6]. This median value represents a conservative WTC_M value for the households in Dhaka City assuming that all no-saying respondents place no value on the BRCP.

A useful way to represent the yes-saying responses is to use a cumulative distribution function, with cumulative frequencies of households willing to contribute for the BRCP on the X-axis and the range of values (Tk amount) on the Y-axis. In Figure 5.6, it can be observed that the higher is the WTC_M value, the smaller is the frequency (cumulative) of yes-saying respondents. As displayed, the curve overall has a negative slope, showing that as the WTC_M amount falls, a larger number of the sample households are willing to contribute money for the BRCP. Relating the WTC_M to the frequency of responses results in a form of a demand curve for the BRCP (see Figure 5.6).

[6] However, the mean and confidence interval may be useful for comparison with estimates from other studies.

Figure 5.6: *Demand curve for the Buriganga River cleanup programme*



There is a large body of literature and many empirical studies dealing with constructing a valuation function[7], mostly by using multiple regression. While very interesting, such results are not crucial to the purpose of this study.

5.2.2 Reasons for Yes-saying and No-saying

All yes-saying and no-saying respondents to WTC_M were asked why they had replied in the way they had. After selecting the WTC_M amount, a follow up question was placed before the respondents as to why they were willing to pay for the BRCP. The frequencies of responses are tabulated in Table 5.8.

As a reason for yes-saying, more than a quarter of the respondents (28.08 percent) stated that on the basis of their understanding people should pay for the services they expect to be provided. Another quarter (25.62 percent) stated that it was the satisfaction from knowing that the river was free from pollution and encroachment. This was followed by the reason "satisfaction from knowing that the river water may be used for future household needs including drinking" (17.24 percent). Fifteen percent of respondents claimed that they were "concerned about water quality in the Buriganga River" and ten percent were of the view that "government does not have enough money to invest". The variety of reasons classified as "others" ranged from a simple 'not sure',

[7] A valuation function is "a statistical way to relate respondents' WTP to their characteristics. In the simplest sense, the respondents WTP or an indicator of that WTP is regressed on respondent characteristics such as income and on preferences relevant to the good being valued" (Carson et al., 1995b: 50).

to 'being unable to decide' to 'requiring more information about the BRCP before being willing to contribute money'.

Table 5.8: *Reasons for yes-saying to willingness to contribute money*

Reasons	**Frequency**	**Percent**
Understanding that people should pay for the services they expect to be provided	57	28.08
Satisfaction from knowing that the river is free from pollution and encroachment	52	25.62
Satisfaction from knowing that the river water may be used for future household needs including drinking	35	17.24
Concerned about water quality in the Buriganga River	31	15.27
Government does not have enough money to invest	22	10.84
Others	6	2.96
Total	203	100
Interviewed sample (n) = 102		

Notes: Total does not match with the total number of yes-saying participants as multiple answers were allowed.
Round-off error exists.

Source: ECV survey.

Only one in four households is willing to contribute money for the BRCP and many households apparently are not willing to pay anything. Compared to the proportion of respondents supporting the BRCP (i.e. 378 out of 400), the proportion of respondents willing to contribute in money terms was far lower (i.e. 102 out of 400). There are several possible reasons why 298 households may not be able or willing to pay for such an environmental improvement. To find out some of the reasons, all the no-saying respondents were asked to state why they had given such an answer. The analysis reveals a number of factors responsible. The responses are tabulated in Table 5.9.

The most common reasons for non-payment were related to income (almost 31 percent of the non-payers), which is an expected outcome in an extremely poor economy. Also, this supports some other studies which identify income constraints as one of the main reasons for non-payment (see, for example, Bateman *et al.,* 1995; Arimah, 1996 and Lauria *et al.,* 1999). This was followed by a surprising outcome that the government should stop corruption and misuse, and reallocate money from less important programmes/sectors to the BRCP (almost 18 percent). About 12.36 percent of respondents who said "no" were opting for a pure "free-rider" reply which was coded as "government's sole responsibility to create such facilities " and 10.79 percent had the attitude "I am not a polluter, polluters should pay". About 10.34 percent lacked the ability to make any decision in this regard, about 8.31 percent feared that money might be misappropriated or misused, 7.41 percent lacked confidence in the success of the BRCP and 2.25 percent gave a variety of other reasons including "not sure".

Table 5.9: *Reasons for no-saying to willingness to contribute money*

Reasons	Frequency	Percent
Don't have enough money to pay for such services	137	30.79
Government should stop corruption and misuse, and reallocate money from less important programmes/sectors to the BRCP	79	17.75
Government's sole responsibility to create such facilities	55	12.36
I am not a polluter, polluters should pay	48	10.79
Inability to make decision	46	10.34
Money may be misappropriated or misused	37	8.31
Lack of confidence in the success of the proposed BRCP	33	7.42
Others	10	2.25
Total	445	100
Interviewed sample (n) = 298		

Notes: Total does not match with the total number of no-saying participants as multiple answers were allowed.

Round-off error exists.

Source: ECV survey

5.2.3 Residents' Contribution Other Than Money

Although the survey participants overwhelmingly supported the BRCP (94.5 percent), only 25.5 percent of them expressed their willingness to contribute money for the proposed BRCP. The estimated average (median) value appears to be very low. In the field survey, it was observed that many respondents were found to be very supportive of the BRCP, but when the question of WTC_M arose, a substantial portion of respondents (about 73 percent of those who supported the BRCP) were found to be unwilling to commit monetary contribution. More than a quarter of the unwillingness was due to financial inability (already discussed above). This was not completely unexpected in an extremely poor economy, because respondents might have other more pressing priorities (e.g. basic food and shelter) to spend their money on.

To complement such a situation, a question was included in the IS – irrespective of respondents' decision for WTC_M, whether they were willing to contribute their own time for the BRCP and whether there was any other contribution they were willing to make, other than monetary involvement. This provided an opportunity for those who could not pay cash but had the willingness to actually do service for the BRCP. Tasks for such voluntary works involved (i) providing physical labour; (ii) participating in campaign and public awareness building; (iii) organizing meeting and rally; (iv) contributing towards non-technical office work; (v) contributing towards technical office work; and (vi) providing consultancy service. Table 5.10 below shows that a total of 131 respondents agreed to provide their time for various activities and services for the BRCP.

Table 5.10: *Willingness to contribute time for the cleanup programme*

	Observed counts	Percent	Expected counts
Yes to WTC_T	131	32.75	200
No to WTC_T	269	67.25	200
Total	400	100.0	
χ^2 = 47.61, df=1, P<0.001			

Source: ECV survey

Table 5.10 shows that the proportion of respondents willing to contribute in terms of time is (131/400=) 0.3275. The 95% confidence interval for the proportion of respondents willing to contribute in terms of time is between 28.15 and 37.35 percent. The small P-value (<0.001) for the chi-square test indicates that there is sufficient reason not to accept the null hypothesis of no difference between the two proportions in the population and thus, the observed differences are significant. Hence, the data indicate that 32.75 percent of the residents of Dhaka City are willing to contribute their time for the BRCP.

Respondents were also asked how many hours per month they were prepared to dedicate to the BRCP. Table 5.11 shows that 82 participants are willing to contribute their time for less than one hour, 39 participants for one to four hours and ten for five to twelve hours. Four were unwilling to answer or unsure about the decision. Two hundred and sixty five expressed their inability to contribute in this form.

Table 5.11: *Respondents' willingness to contribute time in a month*

	Frequency	Percent
Unable to give time	265	66.25
Willing to contribute time	131	32.75
- Less than one hour	82	62.60
- One to four hours	39	29.77
- Five to twelve hours	10	7.63
Don't know/ unwilling to answer	4	1
Interviewed sample (n)	400	100.00

Source: ECV survey

Some interesting responses were received when the question of anything other than money contribution was raised with the respondents. Three respondents opined that they would worship God for the success of the BRCP. One responded that she would fast (not having any food during day time) seeking the divine blessing of God for the successful implementation of the BRCP. One respondent, who participated in the War of Liberation in 1971, said that if required he was ready to go to a similar kind of war against illegal encroachers and industrial pollutants.

An attempt is made in Table 5.12 to monetize the contribution of time for the residents of Dhaka City. The mid-points for the class intervals of (i) less than one hour; (ii) one hour to four hours; and (iii) five to twelve hours are estimated as 30, 150 and 510 minutes respectively. As per the expressed willingness of 131 respondents, a total of 223.50 hours time per month is committed by the participants for the six categories of work. This information together with data on current market rates of wage and salary is used to estimate the WTC_T in monetary terms in Table 5.12.

Table 5.12: *Monetization of contribution in terms of time in a month (in Tk)*

Type of work	**Total hours***	**Money value of WTC_T (in Tk)**
Physical labor	29.42	294.17
Campaign and public awareness building	90.67	1813.33
Organizing meeting and rally	48.50	970.00
Non-technical office work	42.50	1700.00
Technical office work	8.17	1225.00
Consultancy	4.25	2125.00
Total	223.50	8127.50

Notes: Multiple answers were allowed.

* Total hours of work are equally divided among categories of work when respondents show their intention to volunteer time for more than one category.

Source: ECV survey

The required works for the BRCP are divided into six categories ranging from physical labour to consultancy services. Physical labour is required for many activities such as removal of illegal structures, various types of construction work and expansion of sewer lines. Campaign and public awareness building and organizing meetings and rallies appeared as one of the very significant components of the BRCP in the FGDs and while interviewing relevant government departments. These are important for reducing pollution at its sources, adopting treatment measures at the source, building social resistance against encroachers (many of whom are very influential both politically and socially) and creating awareness among citizens for activities such as proper waste management and avoiding the dumping of wastes into the river. Services for both non-technical and technical office work are required for activities such as coordination among different agencies/departments, preparation of tenders, supervision, procurement of materials and execution of the programme. Consultancy services are required for the detailed design of construction, engineering and treatment plants and specification of materials and equipment.

The values of per hour physical labour, work for campaign and public awareness building, organizing meeting and rally, non-technical office work, technical office work and consultancy are estimated at Tk 10, Tk 20, Tk 20, Tk 40, Tk 150 and Tk 500 respectively. These rates, fixed at focus group discussions, are considered to be the market rate for these types of work in Dhaka City in 2001.

The respondents' average value of willingness to contribute in terms of time is estimated as (Tk 8127.50/131=) Tk 62.04 per month (Table 5.12). It is interesting to note that this amount is higher than the direct monetary contribution (WTC_M). The section to follow estimates residents' WTC_M and WTC_T values together in order to derive the non-market benefits of the BRCP.

5.2.4 Economic Value of Non-market Benefits

The amounts of direct monetary and non-monetary contributions (i.e. in the form of time) the residents of Dhaka City are willing to make for the proposed BRCP are estimated. The non-monetary contribution as expressed in time is also converted into monetary values. In order to provide the total non-market benefit estimation, these WTC values are extrapolated for the whole population, which is presented in this section. The total annual value of non-market benefits is shown in Table 5.13.

Table 5.13: *Estimate of yearly non-market benefits*

Category	Amount in Tk
Households' average WTC_M per month (Proportion of household WTC_M: 25.50%)	51.91
Total number of households in Dhaka City	1,107,474
Annual value of monetary contribution (WTC_M)	175.91 million
Households average WTC_T per month (Proportion of household WTC_T: 32.75%)	62.04
Annual value of time contribution (WTC_T)	270.02 million
Total estimated annual non-market benefits	445.93 million

Source: ECV survey and BBS (2001) for number of households in Dhaka City.

According to BBS (2001), the number of total households in Dhaka City was 1,107,474 in 2001[8]. In Table 5.13, a simple aggregate estimate of the total annual WTC across the whole of Dhaka City is derived by multiplying the survey's median annual WTC_M (Tk 51.91) by the number of households in Dhaka City. The result of this product is approximately Tk 176 million per year. The WTC_T value derived in the previous section is also extrapolated for the total population of Dhaka City, which is about Tk 270 million per annum. The total WTC value for the residents of Dhaka City can be estimated by adding these two values which is estimated at about Tk 446 million (Table 5.13). One interesting point here is that WTC_T represents 60 percent of the total value of the non-market benefits. Therefore, the conventional CVM asking only about monetary contribution would have estimated only 40 percent of this total amount. The total value of non-market benefits expected to be generated by the BRCP is estimated as Tk 446 million. Alternatively, this figure can be interpreted as estimates of the gross benefits arising from the BRCP for which market values do not exist as described in *Chapter Three*.

This is a considerable amount of money particularly when the 2001 annual per capita income in Bangladesh of only US$ 387 is taken into consideration. This value is also significant if it is considered that about 55 percent of the residents in Dhaka City live below the poverty line[9]. Such information about residents' willingness to contribute could be extremely valuable for the decision-making body. The application of ECVM allows the residents of Dhaka City to voice the importance of saving the river and to accommodate its non-market value into a monetary economic framework. Also, contrary to conventional belief, it shows that the community does place a value on environmental quality improvement and is willing to contribute for it. Ignoring such non-market benefits would, therefore, clearly lead to an under-estimation of the value of a resource, such as cleaning up dying rivers.

This WTC estimate is very conservative in the sense that during the survey it appeared that a significant number of no-saying respondents were sceptical about the BRCP. Many no-saying respondents mentioned the possibility of misappropriation of

[8] The population excluded from the target population such as floating people and institutional households, servants, guards and caretakers, do not need to be excluded/adjusted from the target population as institutional households and floating people are already excluded from the figure, and servants, guards and caretakers do not form any household in the census count.

[9] The poverty line is defined as the monthly per capita expenditure that purchases a minimum diet which provides an average daily per capita calorie intake of 2122 kilocalorie (PC, 1998).

funds and failure to implement the BRCP due to the lack of political commitment by decision makers and institutional capability of the implementing agency. If the BRCP starts and shows some sign of improvement, public support and contribution could be expected to increase.

5.2.5 Timeframe for the Buriganga River Cleanup Programme

The duration of the BRCP is proposed to be ten years. This type of programme normally requires longer time both for the investment and benefits to mature. However, the timeframe has been limited to ten years (this was also discussed in FGDs) on the basis of the understanding that a longer timeframe may deter some respondents' willingness to contribute and may create a sense of 'too far away to see the outcome'. Out of 400 participants interviewed, 327 agreed to the proposed duration (ten years) of the BRCP (see Table 5.14 below), that means the proportion of agreeing participants is (327/400=) 0.8175 which is statistically significant.

Table 5.14: *Duration of the Buriganga River cleanup programme*

Duration	Frequency	Percent
Less than five years	6	1.50
Five years	33	8.25
6 – 9 years	4	1.00
Agreed to proposed duration (e.g. 10 years)	327	81.75
More than 10 years	24	6.00
Don't know/not sure	6	1.50
Total	400	100.00

Source: ECV survey.

One interesting point to be noted in Table 5.14 is that six percent of respondents are of the opinion that the duration of the payment should be more than ten years. Conversely, about 11 percent believe it should be of less than 10 years' duration. Therefore, it can be concluded that the residents of Dhaka City are willing to contribute Tk 113.95 per household per month for ten years for the BRCP. The ten year duration of the BRCP has been defined as Year 1 to Year 10 in this study; Year 1 means the first year and Year 10 means the 10th or last year of the programme.

5.3 Comparison of Demographic Characteristics Between Sample and Population

A comparison of the demographic characteristics of the residents of Dhaka City between the sample and the population is carried out in this section to see whether these two values are a good match and whether there is any sample bias.

An important question is whether the spatial sample frame actually reflects the characteristics of the population of Dhaka City with reasonable accuracy. This turns out to be a difficult question to come to grips with in a definitive way because of the paucity of publicly available data on the characteristics. The only source of population data on demographic characteristics is the population census report. As mentioned in the previous chapter, the available data on population census was from the 1991 census, although the latest census was conducted in 2001. Except for some aggregate figures, detailed data is yet to be published. Despite the fact that there might be considerable changes of values between 1991 and 2001, I could only use 1991 data for some variables in order to make a comparison with the sample data. Due to the paucity of data, only six comparisons are carried out: sex ratio, age distribution, education, occupation, marital status, income and household size.

Another problem to be overcome is the difference in definition of some variables between the sample and the population data. To count occupation and marital status of residents, the population census defines the population as ten years and over. However, in the sample survey, participants are aged 18 years and over. Age and income categories in the survey are also slightly different from the population census.

Table 5.15 shows data on the distributions of characteristics of the sample and the population. The median monthly household income of the sample is Tk 7237.80 in 2001, while the average household income for residents in Dhaka City in 1999 was Tk 7592/month (PC, 2000)) and after CPI adjustment, Tk 7738.91 in 2001. Therefore, the average income of the sample approximates the reported mean income of the population very closely. The average number of persons per household in the sample is 5.04, while the average family size in Dhaka in 2001 is 4.8. Hence, the average family size of the sample is also close to that of the population at large. The sex ratios of the sample and the population are also seen to be similar. For age structure, the comparison of the sample of households with the distribution of the Dhaka population aged 18 and above seems to present small differences, although this is hard to establish due to differences of classification.

Due to the non-availability of category-wise level of educational attainment, a comparison of the sample with the population data was not possible. However, a comparison was made of literacy rate, marital status and occupation between the sample and the population (see Table 5.15).

Table 5.15: *Comparison of the socio-economic and demographic characteristics of survey participants and residents of Dhaka City*

Variable	Category	Population	Survey participants
Income		Tk 7738.91	Tk 7237.80
Household size		4.80	5.05
Sex ratio (males/100 females)		130.60	139.52
Age (years)		18-34 years: 62.51% 35-59 years: 31.78% 60+ years: 5.72%	18-25 years: 31.50% 26-35 years: 35.75% 36-47 years: 17.00% 48-57 years: 7.25% 58+ years: 0.75%
Education	No schooling	Not available	14.50%
	Primary education		11.25%
	Secondary		14.50%
	Higher secondary		21.75%
	Graduate degree		26.75%
	Post-graduate degree		11.25%
Literacy rate		68.02%	85.50%
Occupation	No work	22.58%	21.00%
	Looking for job	1.73%	8.25%
	Household work	25.69%	22.00%
	Agriculture	0.99%	0.25%
	Industry	4.02%	3.25%
	Water/electricity/gas	0.44%	0.00%
	Construction	1.78%	2.00%
	Transport and communication	3.86%	5.25%
	Business	11.20%	12.25%
	Service	2.06%	13.25%
	Others	25.65%	12.50%
Marital status	Never married	42.02%	37.75%
	Currently married	54.77%	56.25%
	Widow	2.76%	4.50%
	Divorced/ separated	0.45%	1.50%

Source: Survey data from ECV survey and population data (age, occupation and marital status) from BBS (1993), income data from PC (2000) and sex ratio and household size from BBS (2001).

The demographic characteristics of the sample are found to be very close to those of the total population in most cases. Statistical tests can show whether statistically significant relationships exist between the sample and the population values. Tests of chi-square of independence for sex ratio, literacy rate, marital status[10], respondents' occupation[11], household size and income to establish statistically significant relationship between sample and population values provide the following results:

sex ratio: $\chi^2(1) = 0.2946$, P = 0.58
household size: $\chi^2(1) = 0.0063$, P = 0.9367
household income: $\chi^2(1) = 8.4598$, P = 0.0036
literacy rate: $\chi^2(1) = 1.99$, P = 0.158
occupation: $\chi^2(5) = 12.567$, P = 0.027
marital status: $\chi^2(1) = 0.0443$, P = 0.8333.

Therefore, the null hypothesis of independence between the sample and population values for occupation and household income[12] is rejected, and the representativeness of the sample data is found to be statistically significant for the whole population, i.e. residents of Dhaka City. On the other hand, there is no evidence to reject the null hypothesis of independence of sample and population value for sex ratio, household size, literacy rate and marital status.

A visual examination of Table 5.15 reveals no major differences between the sample and population data, particularly taking into account the changing nature of the demographic pattern of Dhaka City[13], although some differences are statistically significant. Therefore, despite these minor discrepancies between the sample and the population data, it can be assumed that the sample is representative of the population.

5.4 Measures of Associations Between WTC_M and Other Variables

This section attempts to detect and describe associations between WTC_M responses and a set of other categorical variables. Contingency tables are used for the *test of independence* of variables. The ECV survey establishes various demographic, behavioural and attitudinal characteristics of the respondents. These variables are analyzed for relationships with WTC_M and WTC_T. Even though these variables may be independent in the population, they may not be (and in fact probably will not be) independent in a sample. Statistical techniques, notably tests of hypothesis, are used to

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10 Cell values less than five were merged which resulted in two categories.

11 Cell values less than five were merged which resulted in six categories.

12 Significant at 10 percent level.

13 Although population growth in Bangladesh is 1.48 percent, it is growing at a rate of 5.5 percent in Dhaka City, and annual growth of slum dwellers is about 6 percent (BBS, 2001 and *The Daily Star*, 14.10.02)

establish the form and significance of these relationships. In this section, testing the null hypothesis is considered, that is, whether in a population two variables are independent on the basis of a sample drawn from that population, or in other wards, WTC_M is independent of the variable in question. The chi-square test of independence is used to determine whether two categorical variables are independent or related (although an association of categorical variables does not imply that one causes the other).

Measuring an association of variables with the WTC_M option can provide evidence about the reliability and validity of the ECV results, since Imber *et al*. (1993) state "[i]f respondents reply in a consistent and theoretically valid way, this constitutes evidence of the validity and reliability of the survey" (p: 133). This is done by determining whether or not the WTC_M values are systematically related to other factors, such as demographic characteristics. A comparison between respondents' WTC_M and a set of demographic and socio-economic characteristics is employed in order to see their association. Responses from the BRA and OBA will also be examined to see if they differ significantly in regard to WTC_M.

5.4.1 WTC_M Responses from the Areas Around the River

As mentioned earlier, the sample was divided into BRA and OBA to see whether the result matches with intuitive expectations. Table 5.16 below shows a simple contingency table where the vertical column represents whether respondents agree or disagree with the WTC_M and the horizontal rows show whether respondents belong within BRA or OBA. One hundred and eighty eight participants in the sample were drawn from the BRA with the remaining 212 coming from OBA. It shows that out of a total of 102 yes-saying participants to WTC_M, 56 are from BRA and the remaining 46 coming from OBA. A chi-square test is carried out to establish whether the recorded differences in WTC_M between the responses of the two sub-samples (BRA and OBA) are statistically significant. The null hypothesis here is that the probability that a respondent within the Buriganga area will agree is the same as the probability that a respondent

Table 5.16: *Willingness to contribute money responses by area*

	Agree	**Disagree**	**Total**
Buriganga River area (BRA)	56	132	188
Outside Buriganga River Area (OBA)	46	166	212
Total	102	298	400
$\chi^2 = 3.43$; df = 1; P = 0.064			

Source: ECV survey

outside the Buriganga area will agree. That is, the null hypothesis is that WTC_M of respondents is independent of the area boundary.

The obtained value of χ^2 (3.43) is smaller than the critical value (3.84). Therefore, the probability that respondents' WTC_M decision does seem to be independent of their location of residence. The hypothesis that the WTC_M is sensitive to proximity to the river site mainly due to familiarity with the area and prospects for resource use/visitation was not found to be statistically significant. For a number of reasons, the Buriganga River is part of every day life for many people of the city. Whilst not that many people live on the river, the Buriganga is also the source of livelihood, recreation and transportation for many people across the city. For these reasons, people living all over the city valued the BRCP.

5.4.2 Respondents' Sex

A question of interest in the study is whether the proportion of males in the population willing to contribute money differs from the proportion of females in the population, i.e. the effect of sex on the distribution of respondents.

Table 5.17: *Distribution of respondents by sex for their willingness to contribution money*

Gender	Yes	No	Total
Male	80	153	233
	(78.43)	(51.34)	(58.25)
Female	22	145	167
	(21.57)	(48.66)	(41.75)
Total	102	298	400
χ^2 = 22.93, df = 3, P <0.001			

Note: Values within parenthesis indicate percentage of column total.

Source: ECV survey

The data in Table 5.17 reveal that females and males have a difference of opinion about their WTC_M. Male respondents appear to be more willing to pay than are females. The difference between the distribution of males and females in the sample appeared to be large. A statistical test could tell whether this difference can be attributed to chance.

The obtained value (22.93) of χ^2 is greater than the critical value (3.84). Therefore, it can be concluded that the difference between the expected and observed frequencies of male and female yes-saying participants is not due to chance. There is a statistically significant relationship between the sex of the respondents and the proportion of yes-saying to WTC_M. This is very much the norm in a male-dominated society like Bangladesh where women usually do not have control of the household's resources, and in line with the intuitive expectation.

5.4.3 Respondents' Household Income

Another way to look at the WTC_M value is as a proportion of the total household income it reflects, rather than as absolute value. Imber *et al.* (1993) state that "[e]conomic theory and the characteristics of the environmental amenities would tend to imply that as income rises willingness to pay for environmental improvements would also rise" (p: 177). Valuation studies in general conclude that there is a strong relation between willingness to pay and personal or household income. Valuation studies find a statistically significant relationship between WTP and household income (see, for example, Carson and Mitchell, 1993 and Lauria *et al.,* 1999).

The distribution of household income across yes-saying participants is presented in Table 5.18. Household monthly income is categorized into nine brackets in the IS as shown in Table 5.18. None of the respondents is from the first bracket (< Tk 1000). A total of 1.5 percent are from the second bracket (Tk 1,000 – 2,000), 10.5 percent from the third bracket (Tk 2,001 – 4,000), 13.8 percent from the fourth bracket (Tk 4,001 – 6,000), 22.8 percent from the fifth bracket (Tk 6,001 – 10,000), 17.5 percent from the sixth bracket (Tk 10,001 – 20,000), 11.5 percent from the seventh bracket (Tk 20,001 – 40,000), 3.3 percent from the eighth bracket (Tk 40,001 – 100,000), 0.8 percent from the ninth bracket (more than Tk 100,000) and 18.5 percent did not agree to disclose their household income. Table 5.18 also provides distribution of monthly household income of the yes-saying respondents by sex. It shows that the bulk of the respondents' monthly household income is above Tk 6,000.

The majority of the respondents (both male and female) are from fifth, sixth and seventh income groups. A comparison between survey participants and WTC_M participants shows that the average household income matters a lot in deciding whether or not to pay for the BRCP. The nine income brackets have been grouped into three levels – low (below Tk 4,000), middle (between Tk 4,001 – 20,000) and high (above Tk 20,001). The comparison between the percentage of survey respondents and WTC_M respondents in Figure 5.7 below shows that the number of yes-saying respondents is comparatively higher in the high than the middle income group. No respondents from the low income group agreed to pay.

Table 5.18: *Distribution of participants' willingness to contribute money by income groups (monthly)*

Income groups	Male	Female	Total
< Tk 1,000	0	0	0
Tk 1,001 – 2,000	0	0	0
TK 2,001 – 4,000	0	0	0
Tk. 4,001 – 6,000	5	1	6
Tk. 6,001 – 10,000	22	8	30
Tk. 10,001 – 20,000	13	5	18
Tk. 20,001 – 40,000	27	3	30
Tk. 40,001 – 100,000	9	2	11
> Tk. 100,000	2	0	2
Don't know/wish to disclose	2	3	5
Total	80	22	102

Source: ECV survey

Figure 5.7: *Comparison between household income of participants surveyed and willing to contribute money*

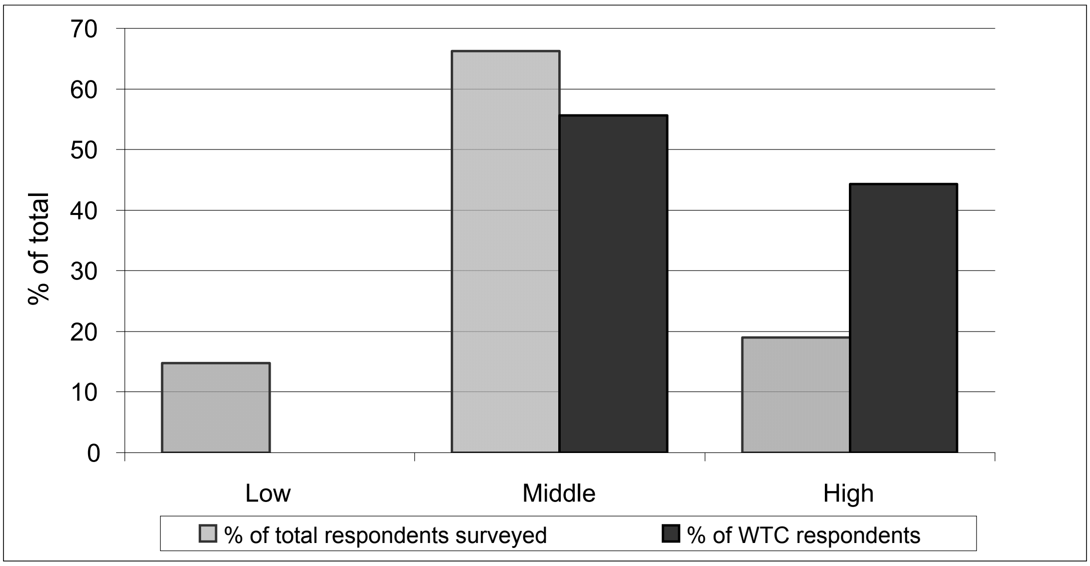


Figure 5.7 clearly shows that the WTC_M decision varies across income groups and respondents' income is seen to be a strong explanation of the WTC_M. Households with higher incomes are willing to contribute in terms of money more than households with lower income.

5.4.4 Respondents' Level of Education

The response to the question regarding educational attainment reveals that 14.50 percent of the sample do not have any formal education, 11.25 percent have primary education, 14.50 percent have secondary education, 21.75 percent have higher secondary, 26.75 percent have a graduate degree, and 11.25 percent have post-graduate education. Table 5.19 below shows that over 84 percent of those responding yes to WTC_M have a higher secondary and above education. Also, education makes a difference regarding participants' WTC_M decision for both males and females. A comparison between the proportion of yes-saying respondents having secondary and above education with the respondents with below secondary education shows that WTC_M is positively related to the level of educational attainment. A significant difference is evident between higher secondary and above, and secondary and below for both male and female yes-saying participants.

Table 5.19: *Distribution of yes-saying to WTC_M participants by gender and level of education*

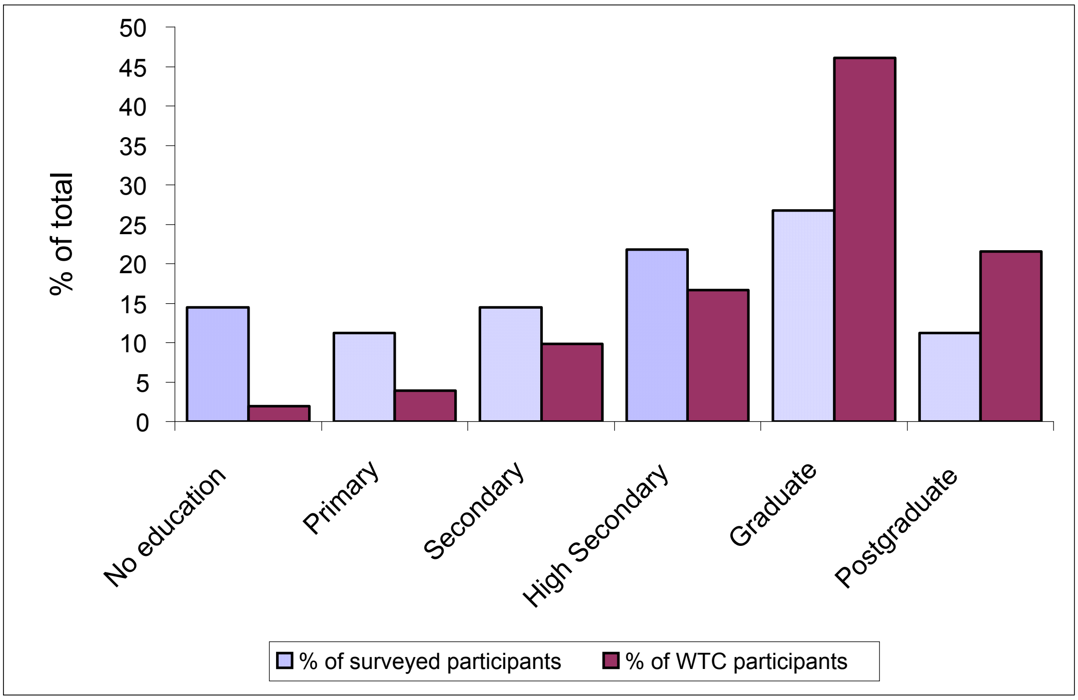
Level of education (years of education)	**Male**	**Female**	**Total**
No formal education	1 (1.25)	1 (4.55)	2 (1.96)
Primary (1 – 5 years)	1 (1.25)	3 (13.64)	4 (3.92)
Secondary (6 – 10 years)	5 (6.25)	5 (22.73)	10 (9.80)
Higher secondary (11 –12 years)	13 (16.25)	4 (18.18)	17 (16.67)
Graduate degree (13 – 16 years)	41 (51.25)	6 (27.27)	47 (46.08)
Post-graduate (16 + years)	19 (23.75)	3 (13.64)	22 (21.57)
Total	80 (100.00)	22 (100.00)	102 (100.00)
Memo:			
Secondary and below	7	9	16
Above secondary	73	13	86

Note: Values within parenthesis indicate percentage of column total.

Source: ECV survey

Figure 5.8 shows a comparison between percentage surveyed and WTC_M participants in terms of educational attainment. It shows that respondents with low education level (below secondary) are willing to contribute less for the BRCP than are respondents with more education (above secondary). It is evident that education at graduate and post-graduate levels influences the WTC_M decision.

Figure 5.8: *Comparison of level of educational attainment between participants surveyed and willing to contribute money*



5.4.5 Respondents' Age

It is interesting to examine whether respondents' decision on WTC_M is related to their age distribution. A comparison between the percentage surveyed and of yes-saying respondents shows that significant difference exists in respect to WTC_M particularly in three age groups (see Figure 5.9). The difference in the 18 – 25 years age group is well understood as most of the respondents are either unemployed or students. The difference among respondents aged 58 and above could be explained by the fact that many do not have decision-making capability in the context of Bangladesh because of their retirement from work. In general, middle-age (between 26 and 47 years) respondents appeared to be more willing to contribute than others. This population group is considered to be economically active.

5.4.6 Current Users of the Buriganga River

An intuitive expectation is that respondents are more likely to be willing to contribute money if they are current users of the Buriganga River. Table 5.20 shows that out of 400 respondents, 66 are both current users and WTC_M, 117 are current users but not WTC_M, 36 are not users but WTC_M, and 181 are neither users nor WTC_M.

Figure 5.9: Age comparison between participants surveyed and willing to contribute money

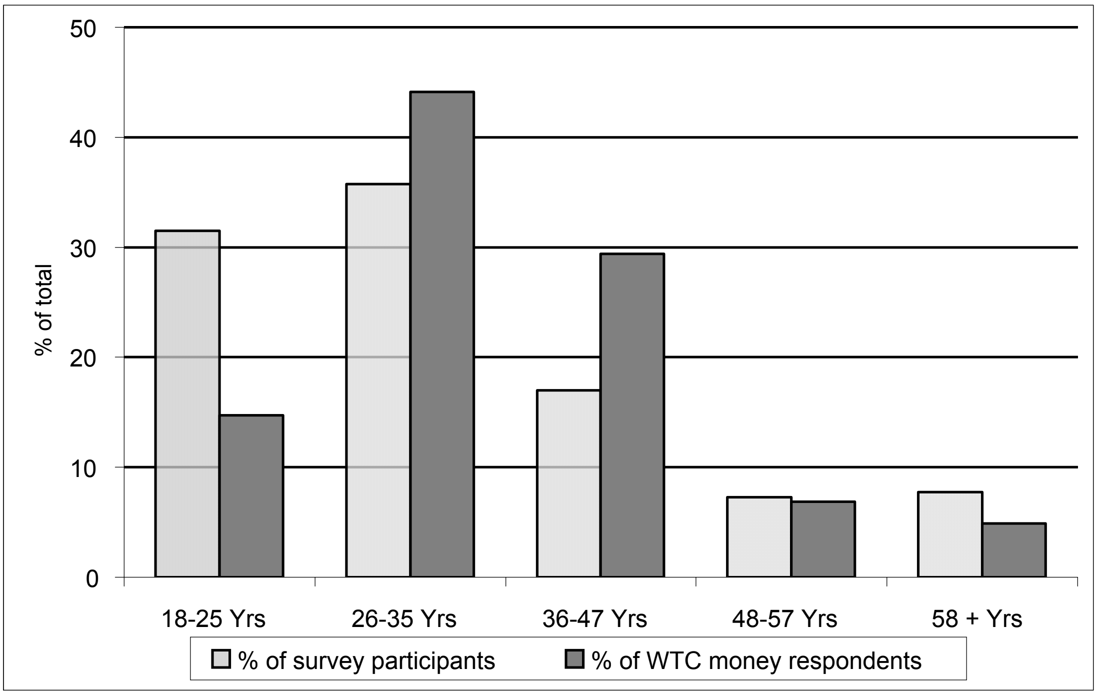


Table 5.20 shows that a higher proportion of respondents are willing to contribute money if they are users than those respondents who are not users of the river resources. Chi-square test examines whether there is a statistically significant relationship between respondents who are current users of any of the resources of the Buriganga River and the proportions of respondents willing to contribute. The χ^2 value is 19.82 which is greater than the critical value of 3.84 at one degree of freedom. The χ^2 test indicates that there is a statistically significant relationship between respondents' current use and their WTC_M.

Table 5.20: *Proportion of respondents* WTC_M *and using the Buriganga River*

	Yes to WTC_M	**No to WTC_M**	**Total**
Users	66 (64.71)	117 (39.26)	183 (45.75)
Non-users	36 (35.29)	181 (60.74)	217 (54.25)
Total	102 (100.00)	298 (100.00)	400 (100.00)
$\chi^2 = 19.82$; df = 1, $P < 0.001$			

Note: Values within parenthesis indicate percentage of column total.

Source: ECV survey

5.5 Validity of WTC_M Responses

There are no previously published similar CVM studies conducted in Bangladesh to provide comparable results to validate the estimated WTC_M value obtained in this study. Comparison with CVM estimates from other countries is difficult for at least three reasons.

First, this is the first time an ECV survey has been conducted for the economic valuation of non-market goods and services (details are discussed in *Chapter Three*).

Second, several studies, as described in *Chapter Three*, have been conducted in which values of the cleanup of rivers are estimated by means of a CV survey. However, comparing results from other studies is clearly a challenge. Not only does methodology differ across studies, but studies rarely provide sufficient information to allow even the calculation of the WTP in a common currency. Moreover, the policy package and the spatial attributes involved in each study differs.

Third, there are differences in socio-economic characteristics, particularly the extremely low per capita income of respondents in Bangladesh.

Owing to these difficulties, the WTC_M value is compared, in the previous section, with a set of demographic and socio-economic variables. The WTC_M responses are seen to be statistically related to various characteristics which provides consistency with theoretical and intuitive expectations. This has become an increasingly common practice in CV studies (Fuguitt and Wilcox, 1999). The WTC_M value is further compared below with the stated income of the survey participants.

5.5.1 Comparison Between WTC_M and Income

The validity of respondents' willingness to contribute for the BRCP is assessed comparing WTC_M amounts with their income. Sinden (1993) puts the point succinctly:

> In any valuation study… realism cannot be justified solely by arguing that respondents followed instructions, that instructions were carefully derived, and that the derivation followed the best available information. Realism must also be justified by a belief in the values themselves, and their direct relationship to income (p: 197).

The IS was checked to see whether the respondents had, in general, answered the survey logically and if the stated WTC_M was too high in respect to the stated income. Although there is no set rule for determining the proportion of WTP to income, Tyrväinen (2001) discards the responses whose WTP answers are more than five percent of the respondents' stated income. Choe *et al.* (1996) find WTP for improvement in surface water quality to be of less than one percent of stated income, while for sanitation benefits from sewerage in Africa figures range between 1 and 2 percent (Whittington et al., 1992). Lauria *et al.* (1999) find that households are willing to pay less than one percent of their household income (50 pesos or US$2) for a connection to a sewer system and a treatment plant in Calamba, the Philippines. The average WTP for wetland conservation is about 0.41 percent of per capita GDP for the United States (Stevens *et al.,* 1995), and the average WTP for wetland conservation in Australia is about 0.47 percent of the per capita GDP (Streever *et al.,* 1998). The WTP as a percentage of income can also be considered in the context of the percentage of household income spent on subsistence requirements.

A review of documentation in twenty-six project loan applications approved by the Inter-American Development Bank (IADB) since 1989 shows that the sample average WTP is influenced by the underlying distribution of income levels across the project sample (Russell, 2001). The relationship between income and stated WTP implies a positive and highly statistically significant income elasticity of WTP of 0.54. Russell states that "[t]he existence of no relationship between WTP and income would be cause for concern about the plausibility of the [contingent valuation] method" (*ibid*, p: 334).

The estimated median household income is Tk 7237.80 per month for this study. The median household falls into the Tk 6,000 to 10,000 income category. Respondents' monthly willingness to contribute money as a percentage of the total household income is found to be less than one percent. Also, WTC_M as a percentage of stated median household income is 0.07 percent.

The TWTC (expressed in monetary terms) as a percentage of stated median household income is 1.57 percent. The TWTC as percent of per capita GDP is 0.64 for the BRCP. Compared with other studies, these figures seem very realistic.

5.6 Reliability of WTC_M Responses

Another question to be raised is how realistic the estimated value of the non-market benefits of the BRCP is. For instance, is there any evidence of a 'yes-saying tendency' among the respondents? That is, when faced with a valuation decision with which participants are not familiar, respondents tend to say yes, either to show interviewers a courtesy or to express cooperative agreement with the interviewer's question. How can the 'yes-saying tendency' be measured? Lu *et al.* (1996) state that "[i]f this 'yea-saying tendency' does exist, we should be able to expect, *ceteris paribus*, a higher percentage of yes replies to given bids in Taiwan than other western countries" (p: 197). Lu *et al.* measured 70.3 and 62.5 percent yes percentage for mail and personal interviews respectively for the benefits of air quality improvement in Taiwan. Although it is not possible to statistically test this proposition, it is expected that carefully designed IS might reduce respondents' unfamiliarity with the valuation scenario. In addition, the policy non-relevance of the survey would reduce respondents' yes-saying tendency. Lu *et al.* (1996) also state that the issue of yes-saying does not exist in a payment card based survey as it is 'unanchored', that is, does not have any indication of a starting value.

Therefore, an attempt is made to compare the $\mathrm{WTC_M}$ estimate with the average payments of utility bills for other public and publicly provided goods and services for the households in Dhaka City. This provides a measure of the value of the good relative to other purchased goods and services. In Table 5.21, payment amounts for water, gas, sewerage, solid waste collection and electricity in 2001 are listed.

Table 5.21: *Utility charges for Dhaka City dwellers*

Utility	**Billed amount (in Tk)**	**Comments**
Water	Tk 4.30 and Tk 12.90 per thousand litres for residential and commercial customers respectively	For a five member family, average monthly water bill is Tk 103.20 (160 litres/day/person)
Gas	Single burner Tk 275 per month and double burner Tk 350 per month. Tk 114.40/million cubic feet for metered users	
Sewer	Equivalent to monthly household water bill	
Conservancy tax	2% of property's annual rental value	Depending on the property, rate is between two to three digits in Tk
Electricity*	Per unit (Kilowatt) of residential use: Up to 300 unit: Tk 2.25 301-500 unit: Tk 3.40 501-700 unit: Tk 4.45 > 700 units: Tk 5.65	For using 300 units in a month, the payment is Tk 675

Note: * as in February, 2002.

Source: Collected from different utility agencies.

In comparison to charges for utility services of residents in Dhaka City, the amount respondents expressed as their willingness to contribute in the form of direct cash for the BRCP, namely Tk.51.91, is not too high and seems to be realistic in the Bangladesh context. Also, this amount is about half of the average monthly water bill of a five-member family. Moreover, the bills and charges presented in Table 5.21 do not include the indirect cost of receiving these services. Many households regularly need to pay an amount of money as a 'bribe' to the utility service agencies simply to continue their services or to lower the bill. Furthermore, a recent World Bank-assisted study states that poor people in slum areas, not connected to utility services such as gas, water or electricity[14], actually pay 50 – 100 percent more than the official rate (*The Daily Jugantor*, 24.5.02).

5.7 Measures of Association Between WTC_T and Other Variables

This section describes the relationships of WTC_T responses with some demographic and socio-economic variables to examine whether these relationships resemble any theories and intuitive expectations. This will help to identify factors influencing a respondent's WTC_T for the BRCP and to examine the validity and reliability of the WTC_T responses.

5.7.1 Willingness to Contribute both Money and Time

Table 5.22 reveals that about 9.50 percent of respondents are willing to contribute both money and time, 23.25 percent only time, 16 percent only money and 51.25 percent neither money nor time. The result shows that more people are willing to contribute time than money. This is expected in a poor subsistence economy mainly due to income constraints for most of the participants. Close to one in two participants are willing to do something about the river. It is important to analyze whether there is any significant relationship between WTC_M and WTC_T.

Table 5.22: *Willingness to contribute both money and time*

	Yes to WTC_T	**No to WTC_T**	**Total**
Yes to WTC_M	38	64	102
	(29.01)	(23.79)	(25.50)
No to WTC_M	93	205	298
	(70.99)	(76.21)	(74.50)
Total	131	269	400
	(100.00)	(100.00)	(100.00)

$\chi^2 = 1.26$; df = 1, P = 0.262

Note: Values within parenthesis indicate percentage of column total.

Source: ECV survey.

[14] As per existing rules, utility services cannot be provided to houses illegally built on *khas* land. Therefore, these services are provided by a group of musclemen with the help of corrupt personnel of the utility organizations.

The obtained value of chi-square of 1.26 is smaller than the critical value of 3.84 at one degree of freedom. There is no evidence on which to reject the hypothesis of no dependence. Therefore, comparison between yes-saying participants to WTC_M and WTC_T does not establish any significant relationship between them.

5.7.2 WTC_T Responses from the Areas Around the River

Out of 131 participants willing to contribute time, 78 are from the Buriganga River area and the remaining 53 are from the outside Buriganga River area (see Table 5.23). Residents within the Buriganga River area appear to be more willing to contribute their time than those of the outside Buriganga River area.

Table 5.23: *Willingness to contribute time responses by area*

	Agree	Disagree	Total
Buriganga River area (BRA)	78 (59.54)	110 (40.89)	188 (47.00)
Outside Buriganga River Area (OBA)	53 (40.46)	159 (59.11)	212 (53.00)
Total	131	269	400
χ^2 = 12.30; df = 1; P <0.001			

Note: Figures in parenthesis indicate percentage of total response.
Source: ECV survey

The chi-square test shows that there is a statistically significant difference ($P < 0.001$) between the preferences in terms of WTC_T in the two communities, i.e. BRA and OBA. Although the WTC_M responses do not show any significant variation between these two areas, the WTC_T responses vary significantly. This may be due to the fact that many extremely poor people live close to the river and they are likely to be the immediate beneficiaries of the BRCP (in the form of new job opportunities, sewerage facilities, clean water for domestic use etc.). This is supported by the fact that nobody in the lower income group expressed their WTC_M (see Table 5.18). However, more than 16 percent of the WTC_T respondents are from the lower income group (Table 5.24). This lower income group residents are not able to contribute money, but are willing to give their time for the BRCP.

5.7.3 Comparison Between WTC_T and Household Income

Table 5.24 shows the distribution of WTC_T respondents' monthly gross household income. It reveals that no single income bracket can be associated with a high proportion of WTC_T. However, if the nine income brackets are regrouped into three

– low, middle and high (similar to the case of WTC_M respondents), a contrast picture can be seen. Although no one from the low income group is willing to contribute money, more than 16 percent of the low income participants are willing to contribute their time. Over 67 percent of the WTC_T respondents are from the middle income group. Eleven percent of respondents either refuse to answer the income question or do not know their household income[15]. This is not unusual when as many as 59.75 percent of the respondents are other than the household head.

Table 5.24: *Distribution of participants' willingness to contribute time by income groups (monthly)*

Income groups	Total	% of total
< Tk 1,000	0	0.00
Tk 1,001 – 2,000	1	0.76
TK 2,001 – 4,000	18	13.74
Tk. 4,001 – 6,000	16	12.21
Tk. 6,001 – 10,000	34	25.95
Tk. 10,001 – 20,000	28	21.37
Tk. 20,001 – 40,000	14	10.69
Tk. 40,001 – 100,000	3	2.29
> Tk. 100,000	2	1.53
Don't know/wish to disclose	15	11.45
Total	131	100.00
Memo:		
Low income	19	16.38
Middle income	78	67.24
High income	19	16.38

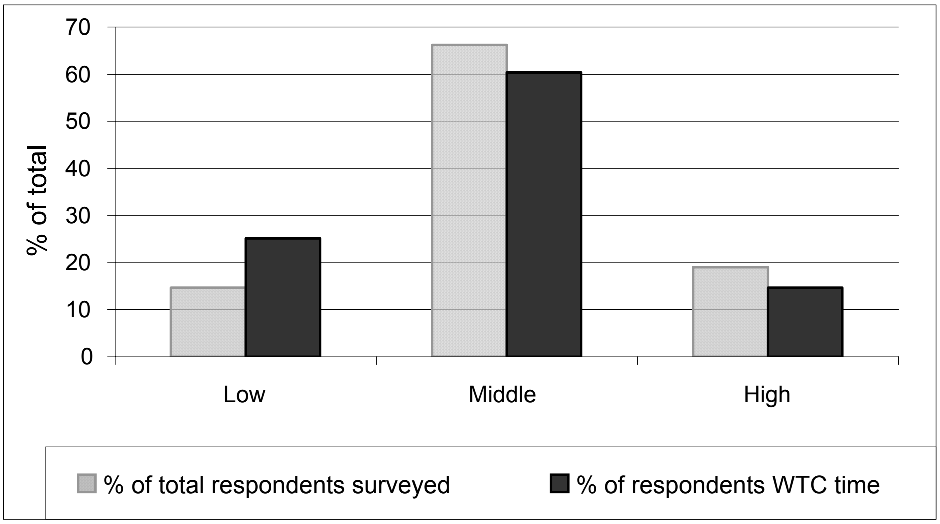
Source: ECV survey

Table 5.24 reveals that over 67 percent of yes-saying to WTC_T respondents come from middle income group. The chi-square test indicates a significant difference among the three income groups ($\chi^2 = 60.02$; df = 2; P <0.001).

A comparison between survey participants and WTC_T shows that participants in the low income group are more willing to contribute their time than middle or high income groups (see Figure 5.10). It is also observed that households with lower income are more likely to reject the WTC_M and propose the WTC_T.

15 Income is considered confidential information in Bangladesh. People in general prefer not to disclose it. This may be due to the tendency of tax evasion. Although as a whole people believed the survey was not linked to any taxation purpose, they feared the information in relation to income may be leaked to tax personnel/department. This is not a phenomenon among rich people, rather common to low income households (in Bangladesh one is in the income tax network if her/his income is Tk 75,000 or more in a year).

Figure 5.10: *Comparison between household income of participants surveyed and willing to contribute time*



5.7.4 WTC_T and Gender

Out of 131 WTC_T respondents, 73.28 percent are male and 26.72 percent are female (Table 5.25). More males are willing to contribute time than females. A statistical test shows significant difference between respondents' sex and their willingness to contribute time (χ^2 = 18.10, df = 1, P < 0.001).

Table 5.25: *Distribution of respondents by sex for their willingness to contribution time*

Gender	Yes	No	Total
Male	96 (73.28)	137 (50.93)	233 (58.25)
Female	35 (26.72)	132 (49.07)	167 (41.75)
Total	131	269	400
χ^2 = 18.10, df = 1, P < 0.001			

Note: Values within parenthesis indicate percentage of column total.

Source: ECV survey

5.7.5 WTC_T and Educational Level

Table 5.26 shows a distribution of WTC_T respondents according to their highest level of education. It reveals that graduate degree holders have significant correlation with WTC_T. If the WTC_T respondents are divided into two educational groups, namely below secondary, and secondary and above, then 71 percent of respondents belong to the latter group. This difference is also statistically significant (χ^2 = 23.09, df = 1, P < 0.001). Therefore, respondents' level of education appears as influencing factor for favouring WTC_T.

Table 5.26: *Distribution of yes-saying to WTC_T participants by gender and level of education*

Level of education (years of education)	**Total**	**% of total response**
No formal education	16	12.21
Primary (1 – 5 years)	12	9.16
Secondary (6 – 10 years)	10	7.63
Higher secondary (11 –12 years)	24	18.32
Graduate degree (13 – 16 years)	50	38.17
Post-graduate (16 + years)	19	14.50
Total	131	100.00
Memo:		
Secondary and below	38	29.00
Above secondary	93	71.00

Note: Values within parenthesis indicate percentage of column total.

Source: ECV survey

5.7.6 WTC_T and Occupation

Table 5.27 presents a correlation between respondents' occupation and their WTC_T. All categories of respondents want to contribute some of their time for the BRCP. About a half of the respondents are either not working (e.g. students) or looking for work. The reason may be that they have more spare time to contribute. Among the working category people, service contributes 14.50 percent followed by business and household work (both 9.92 percent).

Table 5.27: *Respondents' occupation*

Category	**Total**	**% of total response**
No work	41	31.30
Looking for job	21	16.03
Household work	13	9.92
Industry	4	3.05
Construction	4	3.05
Transport and communication	6	4.58
Business	13	9.92
Service	19	14.50
Others	10	7.63
Total	131	100.00

Source: ECV survey

5.7.7 WTC_T and Age

Table 5.28 classifies WTC_T participants into five age groups. Age shows a strong correlation with WTC_T, that is, the lower age groups have a higher percentage of people willing to contribute time. It is found that 78.62 percent of the people who could spare time for the BRCP are below 36. This suggests that age is a major factor for both WTC_M and WTC_T. A statistically significant relationship is found between respondents aged between 18 – 35 years and WTC_T ($\chi^2 = 42.94$, df = 1, $P < 0.001$).

Table 5.28: *Respondents' age*

Age	Total	% of total response
18 – 25 years	58	44.27
26 – 35 years	45	34.35
36 – 47 years	13	9.92
48 – 57 years	9	6.87
58 + years	6	4.58
Total	131	100.00

Source: ECV survey

5.7.8 WTC_T and Uses of the River

About 66 percent of the WTC_T respondents use the river for various purposes (Table 5.29). A test can show whether this difference is statistically significant.

Table 5.29: *Proportion of respondents* WTC_T *and using the Buriganga River*

	Yes to WTC_T	No to WTC_T	Total
Users	86	97	183
	(65.65)	(36.06)	(45.75)
Non-users	45	172	217
	(34.35)	(63.94)	(54.25)
Total	131	269	400
	(100.00)	(100.00)	(100.00)
$\chi^2 = 12.83$; df = 1, $P < 0.001$			

Note: Values within parenthesis indicate percentage of column total.

Source: ECV survey

The obtained value of χ^2 is 12.83. This value is greater than the critical value of 3.84, so the null hypothesis of homogeneity between users and non-users can be rejected. There is a significant difference between users and non-users in terms of their decision to WTC_T for the BRCP.

5.8 Assessment of Validity and Reliability of WTC_T Responses

As mentioned in the earlier chapter, considerable efforts are paid to reduce both sampling and non-sampling errors for the survey. The representativeness of the overall survey sample with the Dhaka City population indicates no problem of sampling error. To minimize non-sampling error, a systematic survey design and careful operation procedure were followed (details provided in *Chapter Four*). All these support the reliability and validity of the ECV survey outcome. Furthermore, the relationships between WTC_T and other demographic and socio-economic variables represent a strong *a priori* expectation which supports the validity and reliability of the WTC_T responses.

The WTC_T component of the ECV method is a new approach developed in this study. In the absence of any similar study to compare the WTC_T value, it is hard to validate the monetary value of the WTC_T. Following Sinden (1993), the validity of the numerical value can be assessed on the basis of realistic, expected, logical and consistent relationship between respondents' preference and their demographic and socio-economic characteristics.

As described in the previous section, the relationships of WTC_T responses with the level of education (i.e. higher levels of education associated with higher proportion of yes to WTC_T), age (i.e. younger respondents are more likely to contribute their time), sex (i.e. males are more willing to contribute than females), household income (i.e. middle income group respondents are more willing to contribute their time) and with location (i.e. people living in the close proximity of the river are more willing to contribute) are logical and resemble intuitive expectations. Also, users of the river have a much higher WTC_T than respondents who have not been users in the past three years. As a whole, it is observed that the WTC_T responses are systematically related to other factors. This lends credence to the preference of respondents for their WTC_T and thus the value derived through the ECV survey. The consistency among responses indicates that the respondents have, in general, answered the survey logically and the stated WTC_T represents their behavioural characteristics. All these results provide a strong support for reliability and validity of the ECV survey.

The validity of the derived values should also be seen on the grounds that customs, cultural beliefs and citizens' behaviour allow such type of altruism in the study area. As described in *Chapter Three*, this kind of non-monetary contribution has enormous significance and social acceptance for many development and philanthropic activities in Bangladesh, particularly in the context of low disposable household income.

Furthermore, a pertinent question is whether yes-saying respondents to WTC_T do really have enough spare time to commit. The ability to contribute time for the BRCP is an important issue. However, statistical information on free/spare time is not available in Bangladesh which makes it difficult to assess the reliability of the survey's results. Nevertheless, about 50 percent of the ECV survey respondents are currently not working or looking for work. Therefore, they have enough spare time to spend on the BRCP. Furthermore, ECV survey respondent's average WTC_T is 1.7 hours in a month which is 1.06 percent of monthly available potential free/spare time (assuming eight hours work, eight hours sleep and eight hours free/spare time and one can work only five days per week). Therefore, the WTC_T responses seem to be realistic.

It is hard to establish the reliability of WTC_T values generated in this study due to the non-availability of previous CV studies using WTC_T values. Nevertheless, the WTC_T value generated by the ECV survey is consistent and logical, and thus valid and reliable as a measure of residents' preference for environmental improvement.

5.9 Socio-Economic and Demographic Characteristics of Respondents Willing to Contribute both Money and Time

The demographic and socio-economic characteristics of the respondents willing to contribute both money and time and the overall survey respondents are compared in Table 5.30. The proportion of respondents WTC money and time is 9.50 percent. Table 5.30 reveals that males are more willing to contribute than females (84 compared to 16 percent). The respondents are almost evenly spread among the various age groups with the exception of the 26-35 group which is overrepresented (with 31 percent) and above 58 which is underrepresented (with 5 percent). Educated respondents (at least a graduate degree or 76 percent) proved to be more willing to contribute. The occupational breakdown of respondents WTC money and time shows that more than half (55 percent) are from the business and service sector. In comparison with the total survey sample, income is found to be associated with a high proportion of WTC money and time. Users of the Buriganga River are more willing to contribute both money and time than non-users.

Therefore, there are particular groups among the Dhaka population who are prepared to contribute more for the BRCP than the rest. In this instance, their concern about the environment and the river is expressed by their willingness to contribute money as well as time for the cleanup programme. Although the share of these people is relatively small, they are an important section of the city's population and represent the people who are most concerned or alarmed about the current status of the river.

Table 5.30: *Demographic and socio-economic characteristics of the willingness-to-contribute both money and time respondents*

Variable	Category	No. of total survey participants	No. of respondents WTC money and time
Sex	Male	233 (58.25%)	32 (84.21%)
	Female	167 (41.75%)	6 (15.79%)
Age group	18 – 25 years	126 (31.50%)	8 (21.05%)
	26 – 35 years	143 (35.75%)	12 (31.58%)
	36 – 47 years	68 (17.00%)	8 (21.05%)
	48 – 57 years	29 (7.25%)	8 (21.05%)
	58+ years	31 (7.75%)	2 (5.26%)
Level of education	No schooling	58 (14.50%	0 (0.00%)
	Primary education	45 (11.25%)	2 (5.26%)
	Secondary	58 (14.50%)	3 (7.89%)
	Higher secondary	87 (21.50%)	4 (10.53%)
	Graduate degree	107 (26.75%)	21 (55.26%)
	Post-graduate degree	45 (11.25%)	8 (21.05%)
Occupation	No work	84 (21.00%)	3 (7.89%)
	Looking for job	33 (8.25%)	2 (5.26%)
	Household work	88 (22.00%)	3 (7.89%)
	Agriculture	1 (0.25%)	0 (0.00%)
	Industry	13 (3.25%)	3 (7.89%)
	Water/electricity/gas	0.00	0 (0.00%)
	Construction	8 (2.00%)	1 (2.63%)
	Transport and communication	21 (5.25%)	1 (2.63%)
	Business	49 (12.25%)	9 (23.68%)
	Service	53 (13.25%)	12 (31.58%)
	Others	50 (12.50%)	4 (10.53%)
Household income	< Tk 1000	0 (0.00%)	0 (0.00%)
	Tk 1,001 – 2,000	6 (1.5%)	0 (0.00%)
	Tk 2,001 – 4,000	42 (10.5%)	1 (2.63%)
	Tk 4,001 – 6,000	55 (13.8%)	4 (10.53%)
	Tk 6,001 – 10,000	91 (22.8%)	12 (31.58%)
	Tk 10, 001 – 20,000	70 (17.5%)	7 (18.42%)
	Tk, 2001 – 40,000	46 (11.5%)	8 (21.05%)
	Tk 40,001 – 100,000	13 (3.30%)	3 (7.89%)
	> Tk 100,000	3 (0.80%)	2 (5.26%)
	Don't wish to disclose	74 (18.50%)	1 (2.63%)
Users of Buriganga River	Users	183 (45.75%)	31 (81.58%)
	Non-users	208 (52.00%)	7 (18.42%)
	Others*	9 (2.25%)	0 (0.00%)

Notes: Figures in parenthesis indicate percentage of category total.
* indicates respondents who could not remember whether they had visited the river.

Source: ECV survey

5.10 Conclusion

Do these survey results provide evidence that households in Dhaka City value the BRCP? The analysis presented in this chapter shows that despite the level of acute poverty and extremely low per capita income, the residents in Dhaka City place a value on environmental quality improvement. The findings of the survey suggest that not only is a significant proportion of the residents willing to contribute money for the BRCP, but many are also willing to contribute in non-monetary ways (mainly their time). When this contribution is monetised, the result is a significant amount. Residents are willing to contribute an average monthly payment of Tk 51.91 for the BRCP, generating an aggregate WTC_M value of Tk 176 million per year. When the respondents' WTC_T is monetised, an amount of Tk 62.04 per household per month is generated. Altogether an amount of Tk 556 million can be generated in a year. This value covers the non-market attributes of the BRCP and will be used to estimate the total value of the BRCP as well as for an extended cost-benefit analysis presented in the next chapter. The survey also provides respondents' priorities, perceptions, preferences and opinions in regard to the Buriganga River which might be useful in targeting public awareness programmes or in shaping policy.

The robustness of the result is in general strongly supported by the consistency of both WTC_M and WTC_T responses with the demographic and socio-economic characteristics of the respondents. The chi-square tests indicate that there are statistically significant relationships between a set of demographic factors and the proportion of residents' WTC money and time. Statistically significant relationships are found between WTC_M and a set of variables such as respondents' sex, income, level of educational attainment, age, proximity to the river, and whether or not respondents' are current users of the river resources. Similar significant relationships between a range of demographic and socio-economic variables and WTC_T are found. It is also shown that the survey participants are representative of the Dhaka population at large.

Alam, Khorshed. (2003). *Cleanup of the Buriganga River : integrating the environment into decision making*. PhD Dissertation. Perth, Murdoch University.

Chapter Six
AN ECONOMIC ANALYSIS OF THE BURIGANGA RIVER CLEANUP PROGRAMME

6.0 Introduction

The purpose of this chapter is to estimate total benefits and total costs of the BRCP in order to integrate environmental considerations into the decision-making process. Assessing the economic viability of the BRCP, by applying the techniques of CBA, requires identification, quantification and valuation of economic benefits and costs. In regard to identification and quantification, some work has already been done in the previous chapters. In *Chapter Three*, the components of total benefit (within the framework of TEV) and major cost components are identified. The total value of non-market benefits is estimated through the ECV survey in *Chapter Five*. This chapter brings together the data and information from *Chapter Five* in estimating the total benefit of the BRCP. Non-market and market benefits are combined to estimate the total benefit of the BRCP. Market benefits are direct benefits which residents can enjoy directly by visiting the riverside or in other ways, and will mainly be available to them through market transactions. Therefore, market benefits are estimated in this chapter using mostly market data.

Chapter Three also identified the cost components (with-programme components) with regard to the BRCP. The quantification of the cost components and their price estimates are required for the ECBA. As the elements of costs are tangible (i.e. market goods), price information can be obtained from both market and secondary sources. The economic analysis of the BRCP carried out in this chapter is an extension of a conventional CBA integrating environmental dimensions, particularly residents' willingness to contribute time (WTC_T). The main purpose of the economic analysis is to examine the viability of the BRCP from the perspective of society as a whole. The approach is based on the conceptual and theoretical framework developed in *Chapter Three*. The ECBA in this chapter is an *ex ante* approach and aims to assist decisions about whether limited resources should be allocated to the BRCP.

The chapter is divided into seven sections. Section 6.1 deals with the assumptions for the economic analysis of the BRCP. The components and costs of the market benefits are described in Section 6.2. In Section 6.3, the total value of the benefits from the BRCP is estimated. The components of cost and their pricing are estimated for the period of the cleanup programme in Section 6.4. Section 6.5 deals with the construction of the cash flow for the economic analysis. Section 6.6 describes the sensitivity analysis, and Section 6.7 contains concluding comments.

6.1 Assumptions

Certain choices and assumptions for the economic estimates need to be made and clarified at the outset of the economic analysis of the BRCP. These are both general and specific to the BRCP and are discussed below.

General Assumptions

General assumptions refer to the overall functioning of the Bangladesh economy and the procedure of cost-benefit analysis. These are described below.

- The conversion factors and discount rate, determined by the Bangladesh Planning Commission, are used in this analysis. An inflation-adjusted real (discount) rate of 10.11 percent is used to derive the discounted cash flows.
- As the ECBA is based on constant (or real) prices, general price contingencies are not included. However, physical contingencies, at the level of 5 percent, are included as they “represent a real change in costs to society” (ADB, 1999a: 122).
- All import duties and taxes (e.g. customs duty and value added tax) are excluded in the economic analysis as these represent ‘transfer payments’.
- The residual values at the end of the project life are normally included in the CBA as a negative cost (or benefit) (ADB, 1999b). However, as already mentioned, the BRCP needs to continue beyond its 10-year implementation period, hence, the residual value is not included in the cash flow (see Table 6.1).
- No major trade liberalization is assumed during the period of the BRCP[1].
- The BBS’s projections on population and household growth rates are used (BBS, 2001), as presented in Table 6.1.

[1] Although, due to adoption of structural adjustment programmes and home-grown reform measures since the 1980s, many restrictions on free-trade have been removed in Bangladesh.

Table 6.1: *Assumptions with specific values*

Items	**Specific value**
Conversion factors	
Standard conversion factor	0.82
Non-tradables	0.82
Discount rate (nominal)	15%
Discount rate (real)	10.11%
Shadow wage rate factor	
Skilled labour	0.82
Unskilled labour	0.73
Annual escalation factor (for benefit components)	5 – 10%
Annual rate of increase (for cost components)	5 – 15%
Replacement cost	Nil
Economic life of the Buriganga River cleanup programme	10 years
Population growth rate in Dhaka City	4.06% per annum
Household growth rate in Dhaka City	5.73% per annum

Assumptions Specific to the BRCP

These are specific assumptions in the sense that they address particular aspects of the BRCP and are described below.

- For valuing the residents' contribution of time for the BRCP, the prevailing wage rates of 2001 for both skilled and unskilled labour are used. An economic wage rate is estimated by applying a shadow wage rate factor of 0.82 and 0.73 for skilled and unskilled labour respectively (see Table 6.1) as per the recommendation of the Bangladesh Planning Commission (PC, 1997), considering the underemployment and unemployment in the study area.

- It is assumed that a continual improvement in the water quality and surrounding environment, and development of physical infrastructure would lead to a continuous increase in some of the benefit components. An annual escalation factor between 5 and 10 percent (see Table 6.1) is used to capture these incremental benefits[2].

- It is assumed that some items of cost components will increase at 5 – 15 percent on a year to year basis. However, in some cases (e.g. items of skilled labour and maintenance dredging for riverbed dredging and construction of landing facilities), a block allocation is made for the item concerned which does not need adjustment with the annual rate of cost increase.

- No replacement of major equipment is assumed within the 10 years of the programme life. Therefore, as a whole, no replacement cost is included. However, expansion costs (e.g. in the case of a compost production plant) are included.

- The economic life of the project is assumed to be 10 years[3].
- Land is valued at its opportunity cost[4].
- All benefits and costs are estimated on the "with and without" programme basis. In the without-programme option, it is assumed that present conditions and practices in the Buriganga River will continue unabated leading to further deterioration of the river health and its environment.

These assumptions are the basis for the economic analysis of the Buriganga River cleanup programme[5].

6.2 Market Benefits of the Buriganga River Cleanup Programme

The value of the components of the market benefits are estimated in this section from market data and secondary sources, such as personal communication through interviews with relevant government departments in Bangladesh, using published or available documents and expert opinion and transferring values from other studies, as described in *Chapter Four*. Market data are derived either from observed market prices or imputed from related markets for the components of the market benefits of the BRCP. Based on the classification of the TEV in *Chapter Three*, this approach can only be used to value goods and services that have established markets. Market prices of goods and services, where necessary, are corrected for market imperfections and policy failures that distort them. In this analysis, the focus is not so much in the absolute numbers, rather in the expected changes. The market benefits include: (i) increased housing and land values, (ii) improved health benefits, (iii) cost saving for domestic and industrial water uses, (iv) increased navigation, (v) increased value of recreation and tourism activities and (v) increased fish production. The estimation of these benefits is described below.

6.2.1 Increased Housing and Land Value

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2 Details are described later in this chapter.

3 However, many benefits are expected to be sustained longer than 10 years. This situation arises from the fact that some of the benefit components are not dependent upon physical structures that deteriorate with age but rather entail new opportunities (e.g. non-use values) that should be sustained long into the future.

4 Normally land price is not included in the economic analysis in Bangladesh when the project/programme uses government-owned, *khas* or unutilized land. However, in this case, land price is estimated at its opportunity cost.

5 A change of assumptions may yields different outcomes.

The improved ecological health of the river will make the land and houses in the surrounding areas more attractive. This will increase their prices as well as the rental value of the properties. A feasibility study would provide a better estimate of the increase in these values. However, an attempt is made to estimate the expected increased value of the land and rental properties using secondary data.

Using the hedonic pricing method, Haque *et al.* (1997) estimate the lost value of land price and rent of housing in the Hazaribagh area due to odor and deteriorated living conditions caused by tannery industries. The estimated value of Tk 53.49 million per month (or Tk 641.88 million per year) for year 2001 (see Table 6.2) is based on the same information adjusted by the consumer price index (CPI) from 1997 to 2001 and the increase in resident population. This benefit is assumed to be achieved in Year 5 of the BRCP. With the continuous improvement of the overall environment and the resulting living conditions, it is also assumed that this initial value will increase at a 5 percent rate between Year 6 and Year 10, which is reflected in Table 6.4 summarising the total benefits of the BRCP for the 10 year period.

In addition, damage to home appliances due to pollution by tanneries was reported by residents living in the Hazaribagh area during my field visit in 2001. This included damage to refrigerators, malfunctioning and a shortened life of television sets, damage to iron products and discolouring of gold ornaments. Due to lack of information, cost savings from avoiding such damage are excluded from benefit estimation. The potential total benefit would be higher if these prevented damage costs were included. Without any detailed study of the increased value of rental loss and property value due to the deteriorating environment in the study area, it is hard to estimate the total benefit. Therefore, the increased housing and land value benefits are conservative estimates of householder benefits in this study.

Table 6.2: *Increased housing and land values and human health benefit in the Hazaribagh area (monthly)*

Category	**Estimated by Haque *et al.* (1997)**	**Adjusted to 2001[a]**
Loss of property values	Tk 13.25 million	Tk 15.16 million
Area in acres	220.00	220.00
Loss of land value per acre	Tk 60,233.54	Tk 68,907.17
Rental income	Tk 33.51 million	Tk 38.33 million
No. of houses[b]	81,044	81,044
Average rental loss due to deteriorating environmental conditions	Tk 413.47	Tk 473.01

Total housing & land values	Tk 46.76 million	Tk 53.49 million
Human health impact	Tk 1.17 million	Tk 1.56 million
No. of persons sick	3,197	3,749
Cost of treatment per person	Tk 364.78	Tk 417.31
Total	Tk 47.93 million	Tk 55.06 million

Notes: [a] In addition to a CPI adjustment, Haque *et al.*'s estimates are adjusted upward by the percentage increase of residents from 1997 to 2001.

[b] The number of people increases in line with the population growth rate of Dhaka City, however, the number of houses is projected not to increase as the area is very compact with no potential to develop new houses or multistoried apartments.

Source: Own estimate based on Haque *et al.* (1997).

6.2.2 Improved Health Benefits

Water-born or water-bred diseases account for a major share of health problems affecting the population on the bank of the Buriganga River. These include vector borne diseases such as malaria, filariasis and dengu hemoragic fever, as well as water-related diseases such as shigella food poisoning, viral hepatitis and typhoid. Such environment-related health impacts are particularly concentrated in the slum areas on the bank of the Buriganga River and among low-income families where access to safe drinking water and proper sanitation facilities is most limited. A major cause of such deteriorating health conditions in the Hazaribagh area is the discharge of untreated effluent from the tannery industries.

The cleanup programme is expected to improve the overall health of the people, particularly those living in the BRA (in close proximity to the river). The expected health benefits are likely to occur with the BRCP due to the improvement in the quality of the river water and the riverine environment. This will be particularly the case if the industrial effluents released from the Hazaribagh tannery can be eliminated or minimized.

People affected by water-borne diseases may have to purchase medicines, consult a doctor or lose a day's wage. Accordingly, health benefits due to the cleanup programme have two dimensions: avoided health expenditures and avoided economic loss due to sickness. It is, however, difficult to estimate the health benefits in monetary terms. Among other reasons, water quality improvement alone may not improve health unless complementary actions are taken, such as hygienic use of water through hygiene education and dietary improvement, especially among low-income families.

It is expected that the BRCP will help to reduce medical bills and lost income due to illness. Haque *et al.* (1997) conducted a survey in 1997 to estimate the cost to human health of the tannery industries. They estimated the cost of health care and lost income to be Tk 364.78 per month per sick person (see Table 6.2). This figure is adjusted in Table 6.2 for the year 2001 taking into consideration the increased population and inflation. The updated estimate of health improvement is Tk 1.56 million per month or Tk 18.72 million per year. This benefit is assumed to be achieved by Year 5 of the BRCP, with an annual predicted increase of 5 percent which results in an amount of Tk 23.89 million in Year 10 (Table 6.4).

The estimate of Haque *et al.* is only for the Hazaribagh area. However, people's health in areas other than Hazaribagh is expected to benefit from the cleanup programme. People living in the BRA are expected to benefit in direct relationship to the degree of improvement in the water quality and riverine environment. Without any detailed study of the human health improvement, it is hard to identify the total number of people benefiting in the BRA. Therefore, the estimated value of savings on the medical costs is conservative for the whole of the study area. Furthermore, Haque *et al.* (1997)'s lower bound estimates[6] are used in this study in order to make the estimate a conservative one.

6.2.3 Cost Saving for Domestic and Industrial Water Uses

Improved water quality in the Buriganga River will save money on total treatment cost, making it cheaper for the water authority (i.e. DWASA) to supply water for domestic and industrial uses. It is assumed that, in the long term, the Buriganga River water will be suitable for drinking and other domestic purposes with simple treatment. Currently, the Chadnighat Water Treatment Plant utilizes water from the Buriganga River to provide potable water to the old part of Dhaka City and its current treatment capacity is 39.1 million litres per day (MLD). In addition, another water treatment plant at Saidabad, 3.5 km downstream of the Buriganga River, started functioning in 2002. The initial treatment capacity of this plant (Saidabad Water Treatment Plant, Phase 1 or SWTP-1) is 225 MLD. Currently the cost of treating a thousand litres is Tk 4.40, while

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[6] Haque *et al.* (1997) provide two estimates, i.e. low estimate based on the actual income loss due to lost workdays and high estimate based on the perceived loss of income.

the selling price of a thousand litres of water is Tk 4.30 for residential and community purposes and Tk 14.00 for industrial and commercial purposes[7]. It is very hard to estimate any figure for cost saving from the cleanup of the Buriganga River water without any detailed technical study. No such information is available. The DWASA applies a rule of thumb to estimate the cost saving for the cleanup of water to be supplied to consumers which is Tk 0.75 and Tk 0.40 per thousand litres of water treated in the Chadnighat and Saidabad water treatment plants respectively[8]. The treatment cost is based on the price of chemicals used in the treatment process, such as chlorine, lime and catflok-T. Based on this information, the cost savings for domestic and industrial water uses from the improved ecological health of the river are estimated at Tk 10.70 million in Year 2 and Tk 43.50 million in Year 3. The estimates for the remaining period are presented in Table 6.4. Although the river water becomes cleaner through time, it is assumed that the annual costs of treatment during the programme period will not decline. However, the cost is likely to decline significantly in later years.

Although ground water is currently the main source of water supply in Dhaka City, in the future this is expected to suffer a number of setbacks. The yearly recharge of the aquifers is less than the abstraction and, hence, the ground water table has been lowered at the rate of on average one metre per year (GOB, 2000). The fall in ground water level causes tube wells to be installed deeper and in some instances it becomes more difficult to pump water from such deep tube wells, particularly in the dry season. The marked seasonal variation in the ground water level also causes water shortage during the summer months. Finally, and most importantly, due to massive arsenic contamination of ground water throughout the country, the Government has shifted its focus to the use of surface water for domestic and industrial uses (PC, 2000). Safe and clean surface water, particularly river water, will become increasingly important as demand for water increases.

The DWASA now supplies 1280 million litres of water in the city daily out of the total demand for 1600 million litres through 349 deep tubewells and two surface water treatment plants (including the one installed in 2002). The DWASA's two proposed treatment plants, SWTP-2 and SWTP-3, are designed to supply 225 and 450 MLD respectively and will be functional by 2005 and 2010 respectively (Kader, 2002). These

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7 As a whole, the water supply is heavily subsidized due to the huge system loss (around 40 percent), failure to collect revenue and excessive administrative cost.

8 Personal communication with the DWASA.

plants will use the water from the Shitalakhya River for purification to supply in Dhaka City. Due to the increasing importance of using surface water as a source of safe drinking water, the water authority (i.e. DWASA) is also considering another project with the capacity to supply 450 MLD by purifying river water (either from the Buriganga or Shitalakhya River) by 2010[9]. If all these plans are implemented, then, by 2010, DWASA will be able to supply 2180 MLD of water against the total estimated increased water demand of 2579 MLD[10], out of which 939.1 MLD (46.96 percent of the total supply) will come from surface water sources. For all these treatment plants, the water quality of the Buriganga River is important, as the Buriganga meets with the Shitalakhya River at Fatullah. As mentioned in *Chapter Two*, in the past the World Bank has stopped the funding to the SWTP, 3.5 km downstream of Fatullah, on the ground that the water in the Buriganga River was beyond purification. By Year 10 of the BRCP, the total estimated cost saving from water treatment will reach Tk 313.50 million (see Table 6.4). Detailed estimates of annual cost saving for treating increasingly polluted water are also provided in Table 6.4.

6.2.4 Increased Navigation

The Buriganga River has an extensive network of inland waterways all over Bangladesh, particularly within the southern districts. As a result, the Buriganga River system has become an important mode of communication. Considering the significance of the waterways for the economic life and development activities of Dhaka, the potential exists to develop a number of facilities, such as inland ports, wayside landing stations and off-shore terminals for ensuring easy and safe movement of passengers and cargo vessels. Currently there are four inland ports on the bank of the Buriganga River; these are Dhaka Port (locally known as Sadarghat Terminal), Postogola, Pagla and Fatulla. The Dhaka Port is the largest river port in the country providing passenger services to all its parts. In 1997-98, the Dhaka port alone earned a total revenue of Tk 98.7 million and its total passenger traffic and cargo handling was 17.2 million persons and 1.97 million tonnes respectively (BIWTA, 1999).

There is potential to develop at least six additional landing stations on the bank of the Buriganga River at Sowarighat, Kantashur, Rayerbazar, Kholamura, Basila and Nababgonj. In a study undertaken by the BIWTA, it is estimated that a total of Tk 2.3

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9 Personal communication with the DWASA.

million in additional revenue could be generated annually from passenger traffic and cargo handling, with at least 7 percent annual growth if these landing stations are developed (BIWTA, 2001). This estimate is used later, in Table 6.4, to measure the total benefits of the BRCP and for the projection of the whole period (i.e. for Year 1 to Year 10). The cost estimate for establishing six additional landing stations on the bank of the Buriganga River is made later in Section 6.4.5.

Although it can be argued that the ecological health of the river has been a minor consideration for such navigation activities in the past, any future developments should be linked to a sustainability agenda and thus should cater for the social, ecological and environmental viability of the Buriganga River and the surrounding areas. Therefore, any increase in navigation without appropriate measures to strengthen the health of the river will add to the environmental and social vulnerability of the city and the country.

An increase in navigation is closely linked with the state of the river. The riverside at present is either underdeveloped or occupied by illegal encroachers. Although the potential exists for these six landing stations, adequate measures such as dredging, river-bank development, removal of illegal structures and channelization in some parts of the river are needed so that the flow of water increases and travel through waterways becomes more attractive and viable. An increase in navigation and, thus, the viability of additional landing stations is considered to be related to the overall improvement of the river.

6.2.5 Increased Value of Recreation and Tourism Activities

To improve water quality and the riverine environment of the Buriganga River will require removal of encroachments, and protection and development of the river-front. Many water-related activities (e.g. water-sports, recreation and tourism) are likely to follow these improvements. The riverine environment will offer the only water-related recreational opportunities to the more than ten million residents of Dhaka City and about 50 million people in the surrounding districts. Without a feasibility study, it is difficult to provide a precise figure for the potential revenue earnings for the government from this sector. Nonetheless, an estimate is made comparing the number of visitors to the existing Shishu Park (Children Park) in Dhaka City. The park is open six days per week and on average, eight hundred people visit this park each day[11]. This makes four

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10 The demand for water in the city is increasing at the rate of six per cent annually.

11 Personal communication with the DCC.

thousand eight hundred people per week. It is assumed that the number of visitors and users of the proposed facilities in and around the Buriganga River will be at least five times bigger than the Shishu Park as they will cover a much larger recreational area and will offer a wider range of activities. By Year 5 of the BRCP, an estimated twenty four thousand people are expected to visit the riverside each week. Although the many activities catering for water-related sports, tourism and recreation, are expected to be developed by the private sector, an estimated revenue of Tk 2.50 million every year (Tk two per person per visit for twenty four thousand users every week) is likely to be generated in the form of recreation taxes and user fees in Year 5, rising to Tk 3.19 million by Year 10 (with an expected 5 percent annual increase between Year 6 and Year 10). This is a modest estimate as the sector is yet to be developed in Bangladesh. Annual revenue estimates from the increased value of recreation and tourism activities are presented in Table 6.4.

6.2.6 Increased Fish Production

The current ecological condition of the Buriganga River is very poor and there is hardly any biological life left in the city parts of the river (already discussed in *Chapter Two*). The lack of baseline information on catch rates or harvest in the Buriganga River makes it very difficult to estimate the potential fish species and fish populations which may inhabit such a riverine environment after the implementation of the cleanup programme. However, it is certain that any water quality improvement will directly benefit fish production. In the absence of more information, the expected benefits are estimated using the benefit transfer approach (i.e. assuming the benefit similar to that of a comparable situation).

Hill and Hanchett (1995, cited in Ali, 1997) estimate an annual fish production of 438 kg per km length of river in the Dhaleswari River. This river is one of the six rivers surrounding Dhaka City. The water quality of the Dhaleswari is considered to be the best among the surrounding rivers (DOE, 2001). Through implementing the cleanup programme, the Buriganga River is assumed to achieve an equivalent productivity within five years and a further 5 percent annual growth thereafter until Year 10. The market value of the increased fish production is, therefore, estimated at Tk 0.89 million per year from Year 5 of the BRCP. For pricing, an average market price of Tk 120/kg of fish[12] is used, disregarding price differences between species. This price is used to estimate the increased fish production for the whole programme period in Table 6.4.

6.2.7 Other Benefits

The increased availability of clean water in the Buriganga River will enhance agricultural productivity downstream. As this is outside the boundary of the study area (agricultural practice is almost non-existent on the bank of the Buriganga River), this was not included in the benefits within the total value framework. Improved flood control and drainage measures may also protect downstream agricultural production, infrastructure, properties, land values and even human lives outside the geographical area of the BRCP. Groundwater recharge might replenish aquifer supplies needed for domestic, agricultural and industrial purposes in other regions. These benefits are not covered due to time and budget constraints in this study, which focuses on the immediate benefits within the study area and is hence a conservative estimate of potential advantages from improving the environmental status of the river. Furthermore, where there are numerous benefits that may impact on the disposable incomes and standard of living of residents, subsequent production, income and employment multiplier effects can generate additional benefits. Although they may be substantial, this study does not consider such effects[13].

6.3 Total Benefit of the Buriganga River Cleanup Programme

All the components of market benefits of the TEV are separately estimated in Section 6.2 above. In this section, market benefits are combined with non-market benefits estimated in *Chapter Five* in order to derive an estimate of total benefit. However, firstly the WTC_T estimated in *Chapter Five* needs to be priced at its "opportunity costs" as outlined in the following Section 6.3.1.

6.3.1 Estimates of Non-market Benefits

Non-market benefits are estimated applying a new approach which modifies the conventional CVM. In this new approach, non-market benefit is derived in a two-staged value elicitation format: asking respondents their willingness to contribute money (WTC_M), and also asking for their willingness to contribute time (WTC_T), irrespective of

12 This is considered to be the market rate in 2001 (personal communication with the concerned official of the Department of Fisheries).

13 A detailed study, such as the Input-Output Analysis supported with environmental indicators, can capture the size and relative importance of indirect and multiplier effects.

their decision as to whether they are willing to contribute money or not. In *Chapter Five*, an estimate is made for respondents' willingness to contribute time (WTC_T). However, there is significant unemployment and underemployment in the study area, which distorts the opportunity cost of labor. This is corrected using the shadow wage rate.

Residents' contribution of time, WTC_T, is shadow-priced on the basis of the assumption made for this study[14] that categories of work are divided between skilled and unskilled labour as follows: physical labour (100 percent unskilled), labour for campaign and public awareness building (25 percent skilled and 75 percent unskilled), organizing meetings and rallies (25 percent skilled and 75 percent unskilled), non-technical office work (50 percent skilled and 50 percent unskilled), technical office work (100 percent skilled) and consultancy (100 percent skilled). On the basis of this information, an estimate is made in Table 6.3 for the shadow price of the potential value of the contribution of time.

In Table 6.3, both skilled and unskilled labours are shadow priced using the shadow wage factor described in Table 6.1. Respondents' average value of willingness to contribute time after adjustment is estimated as (Tk 6374.18/131=) Tk 48.66 per month. The unadjusted value estimated in *Chapter Five* was Tk 62.04, which is 27.50 percent higher. The adjusted value is used to extrapolate Dhaka City residents' contribution of time for the BRCP in Table 6.4.

Table 6.3: *Economic value of residents' contribution of time in 2001*

Category of work	Total hours	Wage rate per hr	Skilled labour (hr)	Un-skilled labour (hr)	Adjusted money value of wage (in Tk)		
					Skilled	Un-skilled	Total
Physical labour	29.42	10	–	29.42	–	214.77	214.77
Campaign and public awareness building	90.67	20	22.67	68.00	371.75	992.84	1364.58
Organizing meetings and rallies	48.50	20	12.13	36.38	198.85	531.08	729.93
Non-technical work	42.50	40	21.25	21.25	697.00	620.50	1317.50
Technical work	8.17	150	8.17	–	1004.91	–	1004.91
Consultancy	4.25	500	4.25	–	1742.50	–	1742.50
Total	223.5		68.44	155.05	4015.00	2359.18	6374.18

Notes: Total hours and wage rates are adopted from Table 5.12 in *Chapter Five*.
hr - hour.
Shadow wage rate factor: skilled – 0.82, and unskilled – 0.73.

Source: Own estimates based on ECV survey.

[14] This is based on expert advice from the Bangladesh Planning Commission and my own experience of working with the project economic analysis.

6.3.2 Estimates of Total Benefits

Respondents' contribution in terms of time is shadow priced above. Other benefits, both use and non-use, are expected to be consumed locally and there are no taxes or duties expected to be levied on them (i.e. on expected net benefit) in the near future (i.e. at least within the period of the programme). Therefore, market prices are assumed to reflect the true value of the outputs. This implies that the market price of the output (i.e. benefits) is also the shadow price, and economic benefits equal financial benefits. Therefore, estimating the benefits at the border price level needs no adjustment.

All components of the TEV from the potential cleanup of the Buriganga River with estimates based on constant 2001 prices are compiled in Table 6.4. The estimation of various benefit components as described in Section 6.2 above is for a single year. This has been extended for the period of the programme (i.e. Year 1 to Year 10) in Table 6.4. This is based on the assumptions made in Section 6.1 and assumed rates of increase described in different parts of Section 6.2.

Many of the benefits are expected to achieve higher levels over the medium (i.e. in five years time) to long term (i.e. in ten years time). Furthermore, some of the benefits are expected to mature in the medium to long term (e.g. fish production). These are reflected in the construction of the total benefit flow in Table 6.4. The total economic benefit of the BRCP is estimated to be Tk 388 million (US$ 6.80 million) in Year 1, rising to Tk 1805 million (US$ 31.66 million) by the end of the BRCP period (i.e. in Year 10) which is a very significant figure. The share of total non-market benefits is 47.31 per cent compared with 52.69 per cent for market benefits for the period Year 1 – Year 10. Also, the adjusted WTC_T accounts for 54.62 percent of total non-market benefits. This clearly indicates the need to account for all benefits when estimating the value a river has to a community and that the share of the residents' contributions (be it through payments or time/labour) is too significant to be ignored.

In terms of contribution to the level of market benefit, the increase in land and rental housing values accounts the highest share (77.71 percent) followed by cost saving for domestic and industrial water uses (19.20 percent) and improved health benefit (2.27 percent) (see Figure 6.1).

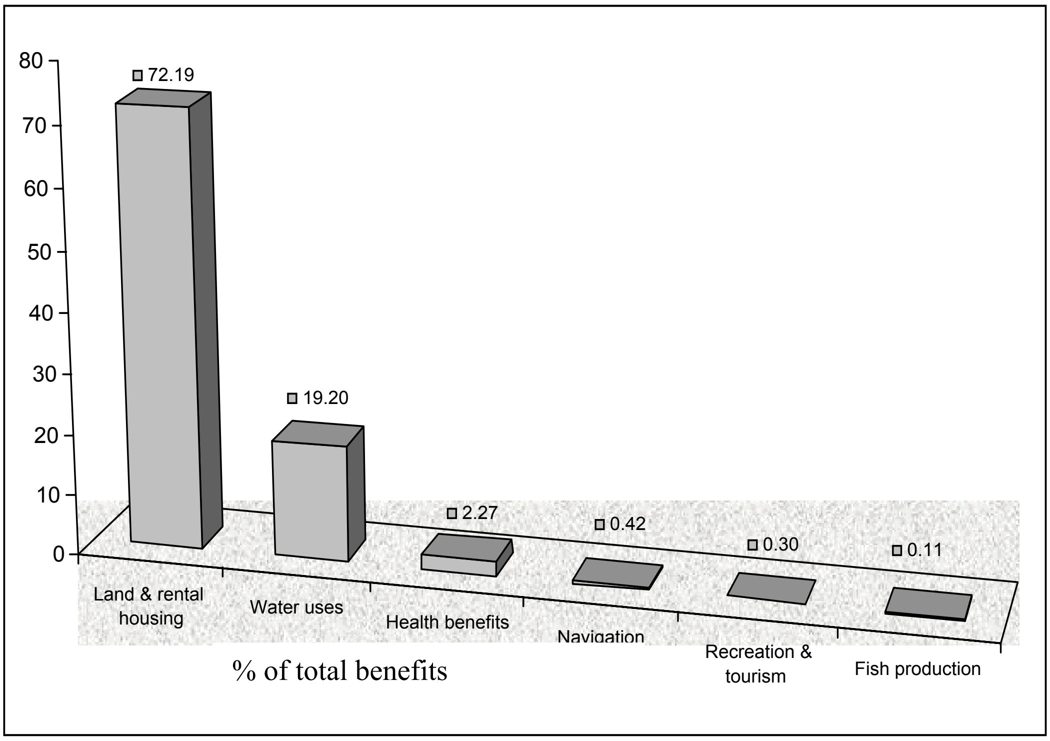
The valuation method provides a careful estimate of the overall community value for the BRCP. Such information can be useful for policy-making and planning purposes as it reflects the desires and aspirations of the residents as well as the realities of the market economy.

As discussed in *Chapter Three*, a comparison with studies conducted in developed countries reveals that the share of non-use value is higher than the use value. In the case of the BRCP, however, the share of use benefits is higher than that for non-use benefits.

Table 6.4

The reason may be that people place comparatively less importance on non-use values because they have more competing requirements, such as meeting basic needs (e.g. food, shelter, medicine, clothing and education).

Figure 6.1: *Contribution of various components of market benefits*



6.4 Components of Costs and their Valuation

The cost estimates of the cleanup programme presented in this section are generated through discussions with the relevant departments during the fieldwork in 2001[15]. Generally, most prices of the cost components are expected to be available in the market. However, as such research is in its infancy in Bangladesh, some cost information is scarce. In such cases appropriate proxies are used. Most of the information is collected from recently published or available documents prepared by the government departments in Bangladesh and adjustments were made after consultation with departmental experts (details have already been described in *Chapter Four*).

The total cost of each component is divided into two broad categories: investment (capital) cost, and operation and maintenance (O&M) cost[16]. Investment or capital costs

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[15] Detailed methods of collecting information through personal communication and deriving estimates for cost of the components through seeking expert opinion have already been described in *Chapter Four*.

[16] The cost categories are highly aggregated; each of the entries represents the sum of a number of individual items. For instance, construction cost consists of various materials such as cement, brick, lime, sand, steel and timber.

are those costs incurred in establishing the Buriganga River cleanup programme, and include costs of equipment, construction, manpower and land. Operation and maintenance (O&M) costs are those incurred in running and maintaining the programme, and include raw materials, manpower, utilities, equipment hiring, and repair and maintenance[17]. These items are estimated on an annual basis. Physical contingencies are also included in the total cost of each component[18]. Physical contingencies are the monetary value of additional resources that may be required beyond the initial estimate to complete the BRCP. Although often calculated and expressed as percentage of the initial (base) costs (ADB, 1997), contingency cost is estimated for this study as five percent of total investment and O&M costs as this cost is 'unforeseen'[19].

The cost components for the BRCP are: (i) removal of illegal structures from the Buriganga River and construction of an access road, (ii) solid waste management, (iii) wastewater treatment, (iv) improved sewerage service and (v) river-bed dredging and construction of landing facilities. These interventions are identified on the basis of the "without-scenario" discussed in *Chapter Two,* and based on the justification of their relevance described in *Chapter Three*. The detailed design of components of costs and their price is described below.

6.4.1 Removal of Illegal Structures from the Buriganga River and Construction of Access Road

It is proposed in the BRCP that after removing the illegal structures from the bank of the Buriganga River, a number of facilities be created. These are: construction of benches and sheds at the right bank of the river along 5.32 km, construction of a bridge, culverts and chutes, river-bank protection by concrete cement blocks and construction of an access road. All investments will be completed within three years from the commencement of the programme. Table 6.5 provides the itemised costs for the removal of the illegal structures from the river and construction of an access road to the river and other facilities. The total cost for a period of 10 years is estimated as Tk 957.69 million. An annual breakdown of the total cost is also provided in Table 6.6.

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[17] Although working capital to run a project/programme is sometimes shown in a different category, in this analysis it is included in the O&M costs.

[18] Although physical contingency is included, price contingency is not included as described in the assumptions.

[19] In the ADB-funded projects, contingencies normally range between 5 and 10 percent and if it exceeds five percent of the base cost, a justification is required in the project document (ADB, 2003).

Table 6.5: *Cost of removal of illegal structures along the Buriganga River and construction of an access road (Million Tk)*

Items	**Costs**
Investment items:	
Manpower	
Skilled	10.00
Unskilled	10.00
Land	
Land acquisition (20.07 ha)	248.43
Duty and registration fee	37.27
Compensation	100.00
Construction	
River-bank protection (7.923 km)	145.12
Construction of bridge (1)	10.00
Construction of culvert (2)	10.00
Construction of chute (5)	0.40
Road (access) construction	10.00
Construction of benches & sheds	2.50
Afforestation (5.32 km)	2.00
Awareness building	130.00
Equipment	4.00
Total investment cost	719.71
Operation and maintenance items:	
Manpower	
Skilled	23.50
Unskilled	33.50
Equipment	1.50
Raw material	19.00
Repair and maintenance	114.87
Total operation and maintenance cost	192.37
Contingency*	45.60
Total	957.69

Note: * Contingency estimated at 5% of total investment and operation and maintenance costs.

Source: Estimates are based on BWDB (2001) and expert advice from the concerned BWDB officials.

6.4.2 Solid Waste Management through Government-Private Sector Partnership

The Dhaka City Corporation (DCC) is responsible for solid waste collection and disposal in Dhaka City. The DCC also has to arrange the sweeping of about 2395 km of

Table 6.6

roads, streets and footpaths and cleaning of about 2463 km of open drains every day. Several studies and experiences gained during the field visit in 2001 reveal that the DCC has failed to provide its service properly. A number of studies have been conducted over the last few years (e.g. Enayetullah, 1995 and Hamid and Huq, 1999) and almost all conclude that (i) it is not possible on the part of the DCC to provide a solid waste management service for a population of about 10 million within an area of 360 sq km; and (ii) private sector participation and decentralization are inevitable. Taking these findings into account, a government-private sector partnership is proposed for the solid waste management in Dhaka City for this study. In the private sector, some local initiatives have emerged to be innovative, locally appropriate, sustainable and viable from an institutional and financial point of view. Two pertinent initiatives are described below.

- **Community-based Organization (CBO):** Over the last few years, local community-based initiatives of house-to-house collection of solid wastes have taken place in many parts of the city. These emerged due to the failure of the DCC to deliver the service. These initiatives are taken mainly by community-based organizations (CBOs), in some cases instigated by the local ward commissioners because of high public demand. These CBOs provide door-to-door collection of waste and then dump it in the community bins to be finally collected by the DCC for disposal into landfill areas. The CBOs charge between Tk 10 and Tk 100 monthly to every household as a service charge. From the perspective of the resident, this system is exceptionally valuable as the neighbourhood is cleaned. However, these initiatives do not match the design of the DCC's communal bins and their timing of waste collection from community bins. In effect, the waste is transferred to a secondary collection point, such as dustbins provided by the DCC or litters the streets. As a result, more waste remains uncollected inside and near community bins. Also, the CBO's initiative focuses totally on house-to-house collection of waste, and does not encourage the sustainable use of resources including the 4R's concept (i.e. reduce, reuse, recycle and recover). In effect, Dhaka City needs to reuse wastes as much as possible as the waste causes problems, such as landfill management and waste collection.

- **Government-Private Sector Partnership:** *Waste Concern*, a private sector organization, has recently initiated a pilot experiment designed to convert organic waste into compost with high economic value. In an attempt to search for an alternative low-cost and sustainable solid waste management method, *Waste*

Concern (WC) initiated a pilot barrel-type composting project in two slum areas in Dhaka City in 1995. The conventional approach of solid waste management is based on the concept of 'collection-transport-dumping of waste'. By comparison, the WC's approach is based on the concept of 'resource recovery, minimization and recycling' (see Box 6.1). In order to achieve efficient solid waste management for Dhaka City, this latter model is replicated in the proposed BRCP for the whole of the DCC. An estimate is made in Table 6.7 of the cost and potential revenue for the DCC on the basis of the WC model of solid waste management.

For this study, the WC model is replicated across the whole DCC under the government-private partnership. Under this proposed approach, the activities of solid

Box 6.1: Waste Concern (WC) – a success story of waste management at the local level

More than 80 percent of the solid waste in Dhaka City is organic (bio-degradable) and contains high moisture levels. Therefore, there is enormous potential to convert the organic portion of the waste into compost, an organic fertilizer which can be used to improve the ability of soil to retain water and resist soil erosion. In the past, the Dhaka City Corporation has not conducted any research to investigate the potential for converting this useful solid waste into resources. Processing of waste in order to produce compost is also important for decreasing the amount of space it occupies at its disposal. This has enormous economic and social importance in an agrarian society as the organic compost of waste can be converted into organic fertilizer and can create significant employment opportunities.

This is what the WC has been doing on a pilot scale. The WC is using an aerobic composting technique. In this process, organic waste is heaped into piles which allows the beneficial microorganisms to decompose the organic waste efficiently. This process takes 45 days, subject to maintaining the temperature and moisture at a given level. At the end, quality fertilizer compost is made from trash. This pilot experiment has been proven to be technically sound and is commercially viable.

A replication of the WC experience throughout Dhaka City would provide significant improvement of solid waste management and reduction of air and water pollution, health risks and waste-volume requiring disposal at the final dumping sites. Thus, composting of solid wastes appears to be a promising way of turning waste into treasure.

Source: Own compilation using information from the newsletter published by the WC (see footnote 20).

waste collection, disposal and management will be delivered by the WC. The role of DCC will be to supervise and monitor the work of the WC, carry waste from community bins to landfill areas and manage landfills. This is in line with the finding of several recent studies which advocate decentralization and privatization of some of the activities of the DCC and also the development of partnerships with the private sector (e.g. Hamid and Huq, 1999).

A cost estimate for the management of DCC solid waste is based on the following considerations. At present WC collects three tonnes of solid waste per day in its pilot plant site at Mirpur Section-2 (Ward No 7) (see Plate 6.1 for Waste Concern's compost production process)[20]. The waste is collected from about 1000 households in Mirpur. The WC charges between Tk 10 and Tk 15 per household per month for waste collection[21] and collects Tk 14.50 thousand monthly. Currently, 675 kg of compost is produced every day by processing three tonnes of waste. It costs Tk 1.70 to produce one kg of organic compost (excluding the cost of land) and its retail price is Tk 6 per kg. There is a good market for the compost all over Bangladesh. At present, 70 percent of the WC's total expenditure comes from compost marketing, while the remaining 30 percent comes from user fees collected from households. The WC sells its compost at Tk 2.50 per kg to two private companies named Alpha Agro and Map Agro which market it across the country at a price of around Tk 6 per kg. The WC's pilot project covers 0.09 percent of the total households in Dhaka City. The WC's expenditure and revenue statements are replicated for the whole of the DCC in Table 6.7. The total expenditure both for capital investment and O&M costs for a period of 10 years is estimated as Tk 630.44 million and is also provided in Table 6.7. A detailed year-wise estimate of total cost for the period of Year 1 to Year 10 is provided in Table 6.8.

Plate 6.1

[20] Information about the Waste Concern was collected through interviewing its Executive Director in June, 2001. Also used are various issues of the newsletter titled *Abarjona O Poribesh* (Waste and Environment) published by the Waste Concern, namely Issue # 1, March, 1999; Issue # 2, July, 1999 and Issue # 3, October, 1999.

[21] The question of double taxation can be raised. In Dhaka City, residents pay a conservancy tax to the DCC for solid waste management services. On the other hand, WC charges an additional fee on top of that. This issue was discussed with one of the WC officials in Dhaka to understand the reaction of residents having to pay twice for the same service. It was revealed that the tax to the municipal authority usually covers secondary collection only. This charge (imposed by the WC) is for extra service of door-to-door primary collection and people in general are happy to pay.

Table 6.7: *Total cost of decentralized solid waste management in Dhaka City over 10 years (Million Tk)*

Items	**Costs**
Investment items:	
Manpower	
Skilled	6.00
Unskilled	10.50
Land (for plant)	9.40
Construction	16.51
Equipment and machinery	8.00
Total investment cost	50.41
Operation and maintenance items:	
Unskilled labour	435.09
Skilled labour	27.46
Utility (water and electricity)	4.92
Maintenance	3.49
Raw materials	79.05
Total operation and maintenance cost	550.01
Contingency*	30.02
Total cost	630.44

Note: * Contingency estimated at 5% of total investment and operation and maintenance costs.

Source: Estimates based on Sinha and Enayetullah (2001) and expert advice from the concerned official of the WC.

A 30-tonne capacity decentralized composting plant in each of the 10 zones of the DCC[22] can serve 12,000 households (based on per capita domestic waste generation rate of 0.5kg/person/day or 2.5 kg/household). Each of the 30-tonne capacity compost plants is capable of generating 6.75 tonnes of compost every day (225 kg of compost from a tonne of solid waste). At a market rate of Tk 6 per kg, a total of Tk 147.83 million can be earned for a year from 10 plants in Dhaka City in Year 1, rising to Tk 1101.38 million in Year 10 (Table 6.9)[23]. Net earning from compost (total sales revenue and user fees minus total cost) is estimated as Tk 84.41 million in Year 1, rising to Tk 1026.90 million in Year 10 taking into account the increased user fees from a bigger population and expansion of the compost capacity in Year 5 (Table 6.9).

22 For its operational purpose, the DCC area is divided into 10 zones.

23 Given the increased supply of compost, its retail price is assumed to remain unchanged during the programme period as the share of compost to the total fertilizer requirement in the country is minimal.

Table 6.8

Table 6.9

Composting organic waste in Dhaka City will also generate 950 new employees (skilled employment of 150 and unskilled employment of 800) in Year 1[24]. Proper and efficient solid waste management will improve the overall environment of Dhaka City which eventually will contribute to reduced morbidity and reduced medical bills. The cost saving from increased health benefits is not included due to lack of data. Consequently, the net benefits estimated in the Table 6.9, are indeed a conservative estimate.

The introduction of community based solid waste management under the proposed government-private sector partnership is not only financially viable, but can help save money on the DCC's conservancy budget. Currently the DCC provides services for community collection (e.g. collection of solid wastes from streets, lanes, by-lanes and dustbins placed in street-corners) and carries wastes to landfill sites. In the proposed

Table 6.10: *Annual budget of Dhaka City Corporation for solid waste management in 1999/2000 (Million Tk)*

Categories	**Allocation**
Service (Investment) expenditure:	
Salaries and wages	168.00
Conservancy material	11.24
Fuel (oil and lubricant)	56.80
Repair and maintenance	36.50
Sub-total	272.54
Overhead expenditure:	
Salaries and wage	17.18
Fuel	2.81
Others	1.20
Sub-total	21.19
Total expenditure	293.74
Total revenue income of Dhaka City Corporation through conservancy tax	126.28
Deficit (subsidy from central government)	167.46
Total revenue budget of Dhaka City Corporation	940.43

Source: Accounts Department, Dhaka City Corporation.

approach, DCC will be responsible only for carrying waste from community bins (secondary points) to landfill sites and the overall monitoring of the WC's activities. As

[24] Each 30 tonne capacity plant requires 15 skilled persons (10 for management of the plant and 5 for distribution and marketing of compost) and 80 unskilled (about 50 part-time waste collectors and about 30 full-time production workers).

a result, a considerable portion of the DCC budget can be saved. The annual conservancy budget (solid waste management) of the DCC is provided in Table 6.10.

In the 1999/2000, DCC spent Tk 293.74 million for the conservancy service which is 31.23 percent of the total DCC revenue budget. Only about 43 percent of the total expenditure of conservancy services comes from the conservancy tax collected from city residents. If household waste collection and disposal of the inorganic waste into communal bins are undertaken by the WC, then part of DCC's conservancy budget can be saved. Without any detailed study, it is hard to estimate the potential savings generated. However, it is assumed that the savings are at least 10 percent of the conservancy budget (i.e. Tk 29.38 million) by Year 2 of the BRCP. The DCC could divert this amount to fund landfill and its management.

As mentioned earlier, the DCC does not have any sanitary landfill sites for ultimate disposal of solid wastes. Solid wastes are dumped in low-lying areas in and around Dhaka City. The dumping sites have filled up very quickly in recent years because of the large volume of waste. Unavailability of land and higher land prices would definitely force the DCC to move its dumping sites away from the city in the future, which in turn would make the conservancy service more expensive. The DCC is finding it increasingly difficult to find new landfill areas located in the periphery of the city mainly due to the scarcity of open space[25]. Community based solid waste management involving recycling and composting could significantly reduce the volume of waste that requires disposal at final dumping sites, thereby reducing pressure on the waste dumping sites. Due to lack of any estimate of cost for establishing sanitary landfill sites, it is not possible to accurately estimate savings from reduced need for landfill. However, it can be said that diversion of part of the DCC budget on sanitary landfill management will ultimately improve total solid waste management and the overall environment of Dhaka City.

In the absence of sanitary landfills, contamination of surface water and ground water by leachates produced at the dumping sites is a major concern. Generation of potentially toxic and explosive gases within dumping sites is another major concern. The analysis of leachate samples collected from the dumping sites shows that these have the potential to contaminate the groundwater, with leachate samples having very high concentrations of BOD, COD, chloride and faecal coliform. In addition, leachates have very high

[25] Personal communication with the DCC official.

concentration of a number of toxic heavy metals including lead and chromium (Rahman and Ali, 2000).

Landfill also contributes to methane gas emission. Reduction of the volume of waste would not only reduce ground water contamination to a large extent, but can also reduce emission of methane and thereby contribute to long term sustainability. Furthermore, the volume reduction of wastes means landfill sites can be smaller in area.

6.4.3 Wastewater Treatment

Among a host of point sources of pollution discussed in *Chapter Two*, pollution by tannery industries has been identified as the most serious environmental hazard to the health of the Buriganga River. Over the last ten years, at least on seven occasions attempts have been made either to move the tannery industry to a new location outside the city or to install a treatment plant for the tanneries at Hazaribagh[26]. Of these two options, in the late 1990s, the Government of Bangladesh decided to establish a treatment plant at Hazaribagh. Since 1999, the United Nations Industrial Development Organization (UNIDO), with the financial support of the Swiss Agency for the Development and Co-operation, has provided technical assistance to develop and design a plan for wastewater collection and a treatment system for the tanneries in Hazaribagh. In 2001, the UNIDO submitted an estimate for a common effluent treatment plant (CETP) on the south-western side of Hazaribagh (UNIDO, 2001a). On the basis of UNIDO's recommendation, the Government of Bangladesh developed a project proposal for establishing a centralized CETP in Hazaribagh in 2001 (DWASA, 2001b). Until August 2003, no action has been taken in regard to the establishment of the treatment plant. For the BRCP, a wastewater treatment plant is proposed for common use by the Hazaribagh tanneries. The cost estimates for the wastewater treatment plant for this study are based on the estimates made in the project proposal (DWASA, 2001b). A minor adjustment has been made in DWASA's estimates due to the fact that the wastewater treatment plant becomes a component of the BRCP. This has been done after consultation with the national consultant of the UNIDO working in Dhaka and concerned officials at the Ministry of Industries.

According to the UNIDO proposal, the effluents and wastewater of all the tanneries of Hazaribagh will be treated centrally in a CETP. Currently, the tannery industries have

[26] Personal communication with the Chairman of the Bangladesh Finished Leather and Leather Goods Exporters' Association.

no on-site or central wastewater treatment facilities. The ultimate destination of all untreated industrial effluents, as well as of domestic waste[27], is the Buriganga River. The CETP will be implemented in two subsequent phases. In the first phase, the preliminary and physical/chemical treatment system will be installed. An aerobic biological treatment system will be installed in the second phase. The treated effluent is to be pumped through a transmission main approximately one kilometre long in order to discharge into the Buriganga River and solid waste/sludge will be deposited in the landfill area. The treated effluent will meet national effluent discharge standards for surface water in Bangladesh. The implementation period for these two phases is five years (the first phase will be implemented between 2001 and 2004 and the second phase between 2004 and 2005).

The tanneries in Hazaribagh process 74,000 tonnes of hides per year. The combined maximum wastewater flow from the tanneries amounts to 21,600 m^3/day. The CETP is designed for a peak flow of 21,600 m^3/day. This flow is based on a peak production level of 400 tonnes of raw hides per day and the inventoried water use in Hazaribagh tanneries of 54 m^3/tonne of raw hide (UNIDO, 2001b).

The cost estimate of the wastewater treatment plant under the BRCP is presented in Table 6.11. The estimates include both investment and O&M costs for a period of 10 years. The total cost including investment cost and an operational and maintenance cost for a period of 10 years is estimated as Tk 2323.35 million. The annual total cost is provided in Table 6.12.

The UNIDO (2001a) has recommended a wastewater levy system for the treatment of tannery effluents. The Government has decided that the tannery owners have to pay an annual levy to cover the O&M costs of the CETP[28]. Collection of the levy would be on the basis of the total annual leather production per tannery. The Government has not yet decided the amount of levy per unit. However, in a personal communication, officials in the Ministry of Industry suggested that the levy might be between Tk 100 to Tk 200 per tonne of hides which may generate an estimated amount of Tk 7.40 million (at a rate of Tk 100/tonne) per year as levy receipts from Year 5 when the CETP will be at full capacity. This estimate is included in Table 6.17.

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27 Hazaribagh is a mixed area with industrial and residential characteristics.

28 Personal communication with concerned official at the Ministry of Industries reveals that a decision in this regard was undertaken in a Steering Committee Meeting on June 24, 2001.

Table 6.11: *Cost of establishment of the wastewater treatment plant (Million Tk)*

Items	**Cost**
Investment items:	
Skilled labour	16.00
Unskilled labour	15.75
Civil works	249.62
Material	354.39
Electrical and mechanical equipment	36.20
Land acquisition	85.00
Consultancy	81.50
Customs duty	152.81
Others	93.07
Total investment cost	1052.59
Operation and maintenance items:	
Manpower	
Skilled	26.07
Unskilled	25.16
Material and equipment	133.96
Transport	33.00
Repair, maintenance and others	208.09
Total operation and maintenance cost	426.26
Contingency*	75.53
Total cost	2323.35

Note: * Contingency estimated at 5% of total investment and operation and maintenance costs.

Source: Estimates based on DWASA (2001b) and expert advice from the concerned DWASA officials.

Table 6.12

6.4.4 Improved Efficiency in Sewerage Disposal System

Human excreta from residents living in shanties developed either on the bank or on the river directly goes to the Buriganga River. Removing these illegal and unauthorized installations will significantly reduce direct sewage outfall into the river. As discussed in *Chapter Two*, many sewer lines are linked directly to the Buriganga River in Sutraput and Lalbagh thanas as the existing sewerage service is inadequate. An expansion of the sewerage service of the DWASA could thus vastly improve the environmental quality in and around the Buriganga River. Therefore, as part of the BRCP, it is proposed that no sewer lines will be allowed to discharge effluents into the river. Strict laws need to be enforced. Sewer lines currently linked with the Buriganga River can then be connected to either existing or newly installed sewer lines of the DWASA.

To facilitate residents living along the Buriganga River, a new 12 km sewer line is proposed to be installed under the BRCP (Table 6.13). Residents will be able to connect

Table 6.13: *Cost of sewer expansion in Dhaka City (Million Tk)*

Items	**Costs**
Investment items:	
Manpower	
Skilled	4.00
Unskilled	11.00
Construction of sewer lines (12 km)	73.05
Construction of one sewerage lift station	4.00
Submersible pump and accessories	14.85
Sludge dewatering pump (2)	2.00
Total investment cost	108.90
Operation and maintenance items:	
Manpower	
Skilled	9.00
Unskilled	37.73
Material	26.05
Chemical	13.03
Repair and maintenance	74.00
Total operation and maintenance cost	160.81
Contingency*	13.49
Total cost	283.20

Note: * Contingency estimated at 5% of total investment and operation and maintenance costs.

Source: Estimates based on DWASA (2001a) and expert advice from the concerned DWASA officials.

their sewer lines to it, instead of the river. The estimated cost (Tk 283.20 million) is shown in Table 6.13. The total estimated cost also includes O&M cost for a period of 10 years. Annual cost components are listed in Table 6.14.

6.4.5 Riverbed Dredging and Construction of Landing Facilities

To restore the natural flow in the Buriganga River and to increase navigability, dredging of the riverbed is essential. Capital dredging along the 17 km channel is proposed under the BRCP. Annual maintenance dredging will also be required. The development of the waterways between Mirpur and Sadarghat on the Buriganga River is expected to boost tourism industries. There is a potential to construct six landing stations along the river from Mirpur to Shadarghat (details about these landing stations are already discussed). In Table 6.15, an estimate is made, on the basis of consultation with BIWTA officials, for both capital and maintenance dredging and construction of six landing stations. This estimate includes both investment and O&M costs for a period of 10 years. Annual cost components are provided in Table 6.16.

6.4.6 Recreation and Tourism Activities in and around the Buriganga River

Once the north bank of the Buriganga River (city side) was a great recreation spot for the residents of Dhaka City. As mentioned in *Chapter Two*, in 1864, *Buckland Bandh* (an embankment on the north bank of the Buriganga River) was constructed. People used to go for evening recreation on the embankment. Due to encroachment and deterioration of water quality over the years, all these recreation sites are closed. It is expected that the implementation of the BRCP will create new opportunities for establishing recreation and tourism activities. The public sector role will be to create physical infrastructure, clear illegal structures from the river-bank and construct an access road, bridge and culverts. Although the recreation and tourism facilities are expected to be developed by the private sector, these will create employment opportunities. The government will be able to generate revenue through user charges and taxes. Therefore, no cost estimate for recreation and tourism activities is included in the BRCP.

Table 6.14

Table 6.15: *Cost of riverbed dredging and construction of landing facilities on the Buriganga River bank (Million Tk)*

Items	**Cost**
Investment items:	
Manpower	
Skilled	2.00
Unskilled	3.50
Land management through lease agreement	10.00
Construction of dyke to accommodate dredged spoil	4.50
Civil works for constructing landing	10.00
facilities	2.00
Bank protection	75.00
Equipment	120.00
Dredging (capital) work	15.00
Compensation	3.00
Consultancy service*	200.00
Coordination	445.00
Total investment cost	
Operation and maintenance items:	
Manpower	
Skilled	10.00
Unskilled	24.55
Maintenance	10.50
Total operation and maintenance cost:	45.05
Contingency**	24.50
Total	514.56

Notes: * Consultancy services are for traffic and hydrographic surveys, site selection of landing facilities, detailed design of jetty/ramp/steps steel gangway, passenger waiting shed, transit shed and dredging alignment.

** Contingency estimated at 5% of total investment and operation and maintenance costs.

Source: Estimates based on BIWTA (2001) and expert advice from the concerned BIWTA officials.

Cost estimates for all the components of the BRCP have been included in this section. In addition, annual costs are presented in order to construct a cash flow, which is done in the following section.

6.5 Construction of Cash-flow for Extended Cost-Benefit Analysis

The estimates of cost components derived so far are based on market or financial prices. However, the economic analysis usually requires adjustments to financial prices to correct for market imperfections and policy distortions as outlined in *Chapter Three*.

Table 6.16

To estimate the economic price of the BRCP over its 10 year duration, the estimates derived in Section 6.4 are used to construct the cash flow for the programme. The difference between the yearly benefits and costs is the net cash flow or net benefit[29]. Curry and Weiss (1993) state that net cash flow allows an "assessment of the project with reference to its overall economic impact regardless of how it is financed and regardless of the project's effect on the government budget" (p: 12).

Discounted cash flow is produced in order to calculate BCR[30]. Both benefits and costs are estimated and entered into the cash flow in Table 6.17 at 2001 constant prices. Cost components from Table 6.6, 6.9, 6.12, 6.14, and 6.16 are compiled to derive the total cost in Table 6.17. A detailed calculation is shown in Appendix X. The benefit flow of the BRCP also includes (i) residents' willingness to contribute money (WCT_M) derived in Table 5.13 in *Chapter Five*, (ii) residents' willingness to contribute time (WCT_T) derived in Table 6.4, (iii) the net sales revenue (total expenditure minus total revenue and user fees) raised from providing solid waste service to households (derived in Table 6.9) and (iv) the levy collected from tannery industries for treating wastewater (an amount of Tk 7.40 million revenue per annum, as already discussed in Section 6.4.3 earlier).

Depreciation of investment (capital) cost is not included as a cost item in the cash flow. The discounting process values the capital items at their opportunity costs over the life of the BRCP. Therefore, imputing depreciation as a cost would result in double counting.

The discount rate used in the ECBA already takes into account relevant factors including the interest rate. The discounting procedure reduces the stream of costs to their present values. Thus, once again, the inclusion of interest as a cost item would result in double counting (Asafu-Adjye, 2000).

In Table 6.17, a financial cash flow for the BRCP is constructed using estimates for each of the components, described above. On the basis of the market price the total cost

29 This is also referred to as project resource statement (Curry and Weiss, 1993).

30 NPV and IRR are calculated using the spreadsheet programme *Excel*.

Table 6.17

of the 10 year duration cleanup programme is estimated at Tk 3344.20 million (investment outlay is Tk 2357.95 million and O&M outlay is Tk 827.00 million). The financial NPV, IRR and BCR are respectively Tk 5530.78 million, 129% and 3.31 at 10.11 percent discount rate. Following the decision criteria described in *Chapter Three*, the NPV is positive, the IRR is higher than the discount rate and the BCR is greater than 1. Therefore, the BRCP is financially viable. However, the purpose of this study is to examine the economic viability of the BRCP from the perspective of the society. This is done below through converting the financial prices into economic prices.

The economic benefits and costs are estimated in border prices in domestic currency, derived from financial (market) prices using conversion factors and shadow prices. Also, the economic analysis is conducted using real price rather than nominal price.

The first step towards converting financial prices into economic prices is to distinguish between tradable and non-tradable goods and to value them at their respective opportunity costs. This is required as tradable and non-tradable goods need different treatment in measuring opportunity cost. Non-tradable goods are valued at shadow prices and tradable goods are valued at world (border) prices (Abelson, 1996). All the items of the cost components are divided into two categories: tradable, and non-tradable[31]. Tradable goods include those that are either imported or exported by the country, such as cement, timber and machinery. Non-tradable items are neither imported nor exported and are used locally, such as land and local transport. This breakdown allows to estimate the economic costs and different shadow prices that apply to the various categories of costs.

The financial cash flow constructed in Table 6.17, is divided on the basis of the tradable and non-tradable goods and services in Table 6.18. In addition, labour is divided into skilled and unskilled. The tradable category usually consists of imported goods, materials and equipment. The non-tradable category usually consists of construction, local consultancy, utility services, local trade and transport.

Without a detailed technical study it is hard to determine the proportion of tradable and non-tradable components of each item in the different cost categories. It is more so in the case of the BRCP as it is a multi-sectoral project involving sectors such as water,

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[31] Some add another category of goods that are not tradable but are potentially tradable (Belli *et al.*, 1997). In this case, this is considered as non-tradable.

sanitation, drainage, solid waste management, wastewater treatment, tourism and recreation and water transport. It is also difficult to estimate the cost of some segregated components such as construction, electricity and water which are important inputs for the BRCP. Government departments in Bangladesh estimate cost on the basis of pre-determined specifications. For instance, construction cost is estimated on the basis of space (e.g. sq ft). It includes all cost such as labour, raw materials and machinery hiring. In this case, it is difficult to estimate further segregated cost on the basis of the use of inputs (e.g. tradable and non-tradable). To overcome this problem, each category is divided into tradable and non-tradable on the basis of a rule of thumb described below. These ratios are set on the basis of expert advice from the Bangladesh Planning Commission.

Different cost components are divided into tradable and non-tradable categories as follows: construction (80% tradable and 20% non-tradable), material and equipment of investment category (60% tradable and 40% non-tradable), land (100% non-tradable), local consultancy (100% non-tradable), others (20% tradable and 80% non-tradable), contingency (20% tradable and 80% non-tradable), repair and maintenance (20% tradable and 80% non-tradable), local transport (100% non-tradable) and material and equipment of O&M category (60% tradable and 40% non-tradable).

To estimate the border prices of tradable goods, all transfer payments, such as taxes/duties, subsidy and compensation, are excluded from the financial prices. However, it appears to be a difficult task to separate out all transfer payments from the financial prices of the total costs. The cost estimates made by different departments in Bangladesh for the various cost components do not show estimates separately for tax and duty. The estimates are inclusive of all such taxes. The only exception is the wastewater treatment plant where tariffs for imported items are estimated separately. Most foreign materials are procured locally through local tender. As such the cost of import duty and custom tariff are included in the cost estimates. To overcome this difficulty, in addition to the deduction of the tariff for the wastewater treatment plant,

Table 6.18

an amount of 10 percent of the total cost is deducted as tax and tariff (custom duty and value added tax). This practice is also common in some sectors of the Bangladesh Planning Commission for the purpose of project analysis[32].

The opportunity cost of labour is derived by adjusting the prevailing (market) wage rate by a factor of 0.82 for skilled labour and 0.73 for unskilled labour in line with estimated levels of unemployment and underemployment in the study area, as per the guidelines of the Bangladesh Planning Commission (PC, 1997).

Non-tradable inputs are valued at their domestic price. A standard conversion factor of 0.82 is used to convert the domestic prices of non-tradable items to their border prices. A summary of the breakdown of the total cost of the BRCP into different components and the conversion to economic values is shown in Table 6.18. The estimates are made by apportioning goods and services into tradable and non-tradable components, and distinguishing between skilled and unskilled labour. A detailed conversion is also provided in Table 6.19 for which values are drawn from Appendix XI.

The total economic cost of the BRCP is estimated as Tk 2564.50 million over the 10 year duration of the programme, which amounts to US$44.99 million equivalent. The total investment cost is estimated at Tk 1755.25 million and the operating and maintenance costs are Tk 676.13 million. All these estimates are at constant 2001 prices. The net benefit calculation is also shown in Table 6.18. The total benefits are drawn from Table 6.17. The total cost is 74.17 percent of total benefit in Year 1, declining to 4.36 percent of total benefit in Year 10. The incremental net benefit is Tk 121.96 million ($2.14 million) in Year 1, rising to Tk 2715.21 million ($47.64 million) by the end of the programme (i.e. in Year 10). This indicates that the cleanup programme will generate more benefits in the later years of the implementation period. It is assumed that within the 10 year implementation period, all the capital investment will be completed and the programme will start to generate full benefits.

The summary statistics of the economic analysis for the BRCP are the NPV, IRR and BCR, as described in *Chapter Three*. These are also presented in Table 6.18.

Table 6.19

32 Expert opinion from the concerned official at the water sector of the Planning Commission.

The discount rate (nominal) is set at 15 percent and the real rate is 10.11. Therefore, the BRCP will be acceptable if the IRR is above 10.11 percent, or if the NPV is positive, using a 10.11 percent discount rate as a measure of the social opportunity cost of capital. The NPV at 10.11 percent discount rate is Tk 6100.89 million ($107.03 million). The IRR is 822 percent, which is well above the opportunity cost of capital of 10.11 percent. The BCR is 4.24 at 10.11 discount rate. All three criteria of the ECBA are satisfied. Therefore, it can be concluded that *the BRCP is economically viable*.

6.6 Sensitivity Analysis

A sensitivity analysis is carried out to test the "possible impact of uncertainty by posing 'what if' questions. These questions pertain to what would happen to the project's viability if some or all of the key parameter values happen to be different from the original values" (Asafu-Adjaye, 2000: 155). It is difficult to examine the impact of all the potential parameters on the BRCP viability. There may be many variables which can affect the viability of the BRCP. A separate detailed study would be required to identify all these factors which is outside the purview of this study. However, on a limited scale, the viability of the BRCP has been examined with regard to its sensitivity to any exogenous factors. For a sensitivity test, six possible scenarios are considered. These are described below:

Scenario 1: total cost increases by 10 percent annually
Scenario 2: total benefit expected to be generated fails by 20 percent annually
Scenario 3: a higher annual discount rate (real) is used, namely, 15 percent
Scenario 4: a lower annual discount rate (real) is used, namely, 7 percent
Scenario 5: non-market benefit is considered zero
Scenario 6: residents' willingness to contribute time (WTC_T) is considered zero.

The outcome of the sensitivity analysis is presented in Table 6.20. The programme performance criterion used in the sensitivity analysis is NPV, i.e. the effect of possible changes on the viability of the BRCP is calculated in the form of NPV, while varying one variable and holding the others constant. It can be seen in Table 6.20 that in all six scenarios, the NPV remains positive. Therefore, the viability of the BRCP is not sensitive to any of the scenarios considered here. Thus, the BRCP allows for negative changes which will reduce its net benefit but will still remain positive.

Table 6.20

6.7 Conclusion

As discussed in *Chapter One,* public sector investment in environmental improvement in Bangladesh is not adequate. Not only is there a scarcity of public funding, but a perception exists that the benefits of such undertakings are minimal in comparison to costs. This is one of the reasons for under-investment and massive destruction of natural resources for which there is no market.

To examine this proposition, the case of the Buriganga River Cleanup Programme was developed to estimate total benefits and examine the desirability of this programme from the perspective of the community as a whole. The application of ECVM reveals that the BRCP is able to generate significant benefits. The total benefit is estimated at Tk 15068.36 million, which clearly outweighs the cost (i.e. Tk 2564.50 million) of undertaking the BRCP. The estimated total benefit is a very significant figure for the economy of a poor country like Bangladesh. Thus, a failure to account for such benefits could lead to gross under-estimation of the desirability of providing public funding for the cleanup of dying rivers in Bangladesh. The extended cost-benefit analysis also reveals that investment for the BRCP is worth undertaking.

Although the findings are based on a single river in Bangladesh, the analytical framework is more widely applicable to wherever natural resources are subject to degradation due to missing markets or market imperfections. Public sector investment in developing countries like Bangladesh needs redirection to respond to emerging environmental problems such as water and air pollution and global warming. On the basis of the findings of this chapter and the results and discussions in the previous chapters, policy recommendations and conclusion are drawn together in the next chapter.

Alam, Khorshed. (2003). *Cleanup of the Buriganga River : integrating the environment into decision making*. PhD Dissertation. Perth, Murdoch University.

Chapter Seven

CONCLUSION AND POLICY RECOMMENDATIONS

7.0 Introduction

This chapter summarizes the major findings of this research and formulates recommendations which contribute both to informed policy making and the body of theoretical knowledge. In doing this, an attempt is made to answer the research questions of the study formulated in *Chapter One*. This chapter also provides some suggestions on further research that is required for improving the methods and practices of ECV and ECBA as well as to examine its applicability to other environmental problems.

7.1 Summary of Major Findings and Conclusions

The summary and conclusions are broadly categorized into the following areas: (i) the cleanup of the Buriganga River; (ii) water management in Bangladesh with particular reference to vulnerable rivers; (iii) economic valuation of non-market goods and services; (iv) cost-benefit analysis; and (v) public sector investment decision making. These are described below.

7.1.1 Cleanup of the Buriganga River

The Buriganga River was selected as a case study for an in-depth analysis of the problems of rivers and to examine the applicability of the ECVM developed in this research which estimates the non-market benefits of the cleanup programme. The water quality of the Buriganga River and sources of pollution indicate that the river needs immediate intervention. It is evident that there is a strong need for the BRCP to start immediately. The dangerous biological death limit for the river has already been crossed.

This study suggests that the Buriganga River is highly valued by the people of Dhaka City. The analysis of the ECV survey (see *Chapter Five*) reveals that respondents overwhelmingly support the cleanup programme.

From the ECV survey, it becomes clear that:

- The non-market values of the BRCP are significant. The total value of the cleanup programme from market and non-market sources is around Tk 388 million ($6.80 million) per year of which about 47.31 percent can be attributed to non-market uses. On an average, a respondent is willing to contribute Tk 113.95 per household per month of which Tk 62.04 is in the form of time.
- A significant relationship between respondents' income and their WTC_M is observed and low income households are proportionately more willing to contribute their time.
- Residents' perceptions and opinions revealed through the ECV survey could be useful in targeting education and awareness programmes, setting priorities and in shaping policy.
- The cleanup programme involves huge investment. Often such steps are hindered due to lack of investable funds. The ECV survey reveals that considerable funds can be generated from within the community through appropriate mechanisms.

The market benefits of the BRCP include: (i) increased housing and land values, (ii) improved health benefits, (iii) cost saving for domestic and industrial water uses, (iv) increased navigation, (v) increased value of recreation and tourism activities, and (v) increased fish production.

The cost components for the BRCP are: (i) removal of illegal structures from the Buriganga River and construction of access road, (ii) solid waste management, (iii) wastewater treatment, (iv) improved sewerage service, and (v) river-bed dredging and construction of landing facilities.

An extended cost-benefit analysis was conducted, using both survey data (for non-market goods and services) and secondary information (for market goods and services). The results show that public funding of the cleanup of the Buriganga River is worth undertaking from the point of view of the society as a whole. The NPV at 10.11 percent discount rate (real) is Tk 6100.89 million, the IRR is 822 percent and the BCR is 4.24.

7.1.2 Water Management in Bangladesh with Reference to Vulnerable Rivers

Although surface water is abundant in Bangladesh, the quality of water has become the main constraint in the development of a safe and affordable water supply system. Surface water is being misused as a sink for highly polluting wastewaters from municipal and industrial sources. Bangladesh needs to protect the quality of its surface water, particularly river water, as an alternative source of water for drinking, irrigation, industrial and other beneficial uses, particularly in the context of arsenic contamination of ground water. In view of the problems experienced during the dry season in many parts of the country, Bangladesh needs an efficient water management strategy for its rivers. Moreover, as surface water and ground water are inter-related, the quality of ground water can only be ensured through better protection of surface water and ground water recharge areas.

Maintaining water quality has emerged as an important issue. Rivers near cities are facing problems stemming from the narrowing of river channels due to encroachment and unplanned development and the dumping of untreated industrial effluents. These problems are inter-related and they need an integrated and holistic approach in order to be resolved. This approach is adopted in the cleanup programme developed in this study. It should be understood that river cleanup programmes should start from the land – the source of both point and non-point pollutions, as identified for the Buriganga River, rather than simply focusing on activities in and around the river. Moreover, because of the scale of the problem rivers in Bangladesh face, there is a need for government intervention.

Not only is investment in river management limited as a whole in Bangladesh, but environmental quality improvement is not a priority area as most of the benefits are non-market and intangible as per the conventional approach of benefit measurement. An alternative approach has been developed in this study which is able to (i) estimate non-market benefits of environmental improvement, (ii) integrate the non-market benefits into the policy decision making, and (iii) demonstrate how investable funds could be generated from the community.

7.1.3 Applicability of Valuation Technique and Economic Valuation of Non-market Benefits

There has been surprisingly little empirical work on economic valuation of non-market goods and services in developing countries and Bangladesh in particular. With this in mind, this study is an attempt to meet this need and contributes to filling this vacuum in the policy-making field.

The research uses ECVM as the context in which to explore the implications of a model of improving or modifying practice so as to better inform the social decision making in a developing country context.

The question that is asked in this study is to what extent is this valuation procedure different from existing practices. It is revealed that the standard valuation techniques developed in the industrialized economic setting have serious limitations when applied in developing countries. Many of these techniques assume conditions which may not be met in developing countries. To overcome these limitations of the CVM, an extension of the conventional CVM is developed in this study in regard to framing the valuation question. The distinctive feature of this extended CVM (ECVM) is that it asks respondents about their willingness to contribute time in addition to asking their willingness to contribute money in order to elicit preferences for the good in question. The purpose was to evaluate respondents' reactions to the valuation question and thereby provide a methodology applicable in the developing country context.

Some adjustments were also required in the method of designing the survey instrument and the execution of its operation. This was due to the fact that the study area is an extremely poor economy and the society as a whole is male-dominated. These adjustments include the exclusion of some sections of the population from the sample frame, such as the floating population (e.g. beggars, homeless and vagabond people and itinerants), servants, guards and caretakers who do not form a household.

The application of ECVM reveals that in every case of benefit estimation, local cultures and conditions matter. It is not enough, or may even be misleading, to import methods, arguments and conclusions from developed and other countries without modification. It also suggests that economic valuation is important because society confronts difficult policy choices about maintaining environmental resources and on resource allocation, while fiscal resources are finite. As a result, making choices involves implicit, if not explicit, trade-offs among preferences. This study provides insights into the feasibility of measuring such values directly.

The study suggests that public contribution has the potential to provide a significant source of revenue for further management of degrading resources. Additional funds could be raised from the public by introducing an appropriate payment mechanism for environmental improvements.

The application of the ECV technique is important for decision making insofar as it takes into account the unpriced or underpriced outcomes of the proposed policies or projects. Although the technique is not perfect, the inclusion of non-market values in the decision-making calculus helps to clarify the trade-offs and will allow the decision-makers to make better informed choices.

7.1.4 Incorporation of the Environment into Decision Making

If fair and rational decisions are to be made, non-market environmental goods and services need to be incorporated into the decision-making process. This is achieved through an extended cost-benefit analysis (ECBA). The ECBA is employed to determine the desirability of public funding for the BRCP. Particular attention is paid to the valuation of non-market goods and services. These values are then integrated into the conventional CBA to obtain more correct measures of the social profitability of the BRCP. Where ECBA recognizes the non-market goods and services associated with the cleanup of rivers, it can provide important information to decision-makers in selecting appropriate management strategies. Failure to find and implement the appropriate management strategy can lead to substantial economic losses and ecological degradation (particularly where the river system supports important traditional livelihoods) as well as increased social and political instability.

Even applying this relatively conservative approach to benefit estimation, it is plausible to conclude that the willingness-to-contribute for the benefits of the cleanup of the Buriganga River would be sufficient to undertake such a programme. The study of the BRCP shows that the integration of the environment in the form of capturing the full value of benefits into economic analysis is possible.

7.1.5 Policy Decision Making with Reference to Public Investment in Bangladesh

Many natural resources are over-exploited in Bangladesh because, *inter alia*, markets for them are imperfect in the sense that they are either missing or not fully developed. Investment decisions are also misguided as the benefits of some goods and services (e.g. environmental improvement) are non-marketed. If the value of environmental goods is known, it can be determined how to allocate their use efficiently. Failing to value environmental resources correctly is found to be an instance of general mis-allocation and distortion in investment decision making. Consequently, although many areas of the economy, such as the water sector, deserve investment, this is patchy as such investment invokes non-market benefits.

The proper valuation of non-market environmental goods has significant policy implications. As many of the environmental impacts are non-marketed, one extremely important policy measure is to ensure that, as far as possible, the 'true' economic value of environmental resources is accounted for when making investment and environmental policy decisions. Such goods have been assigned zero[1] or low values due to difficulties involved in determining the economic values. Failure to properly account for the values of some environmental resources has resulted in decisions that have had negative implications for the environment and society, such as depletion of wetland resources in Bangladesh.

Policy decisions are often misguided if benefits are under-estimated in comparison to the costs of such undertaking. Failure to account fully for the environmental benefits of an action (e.g. project, programme or policy) means that its net economic worth is misrepresented. Continuing such practices will have long-term negative impacts on the ecology and sustainable development. The change is long overdue and this study has demonstrated a possible solution.

The BRCP is only one example of the application of the ECV approach, however, the techniques and approaches have wider applicability, including in developed countries.

7.2 Policy Recommendations

What policy recommendations could be made from this research study? This section attempts to answer this question. It has practical applications in terms of what the results can contribute to informed policy making. Specifically, results of the previous chapters are targeted to aid the policy-making field by answering two specific questions: (i) what needs to be done locally to save the dying rivers, and (ii) what can be done to improve the investment decision-making process in Bangladesh?

7.2.1 Local Actions to Save the Buriganga River

A combination of interventions – pollution control measures, better coordination, strengthening institutional capability, policy reform and community participation, are identified as the main measures to save the Buriganga River. These are summarized below.

Pollution Control Measures

Both point and non-point sources of pollution need to be contained and treated properly in watersheds to maintain the water quality in the Buriganga River.

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[1] Zero price in the sense no market place exists in which their true values can be revealed through the acts of buying and selling.

Better Coordination Among Agencies/Parties

There are seven government ministries and 14 agencies involved, in one way or other, with the Buriganga River management. However, nobody takes responsibility for caring about the river. Many agencies are undertaking development projects without any consultation with others. This not only instigates mis-use of resources, but also creates problems. Establishment of appropriate coordination among the stakeholders is found to be very important.

Strengthening the Institutional Capability

A taskforce is proposed to carry out the cleanup programme of the Buriganga River involving all agencies including Bangladesh Inland Water Transport Authority, Dhaka Water and Sewerage Authority, Dhaka City Corporation, Department of Environment, Ministry of Industries, Ministry of Shipping, Ministry of Water Resources and Planning Commission. A permanent secretariat could be stationed at the DWASA office. Appropriate authority needs to be given to such a body. The sensitivity analysis shows that the BRCP is insensitive to external factors such as failure to mobilize resources up to 20 percent. Nevertheless, the analysis of past initiatives to save the river reveals that political will is important and needs to be established at the outset of the cleanup programme.

Policy Reform

Although a number of rules and regulations exist to ensure that efficient control measures are in place to improve the environment in relation to the Buriganga River, these need to be reformed in the present context. Past efforts involving physical demolition of illegal structures did not solve the problem. As no legal action was taken against the encroachers, the demolition was quickly followed by re-occupation of the recovered spaces by the same illegal occupiers. It is necessary to reform the existing laws to provide exemplary punishment to the offenders. Enforcement of control and monitoring measures is also ineffective because of the lack of trained enforcement officers and the capacity and legal powers of local authorities (i.e. at the agency level) and these need to be strengthened. The existing regulatory measures are inadequate to deal with the emerging urban governance crisis, such as solid waste management and the sewerage disposal system. Therefore, new rules and regulations are required in the following areas:

- Ban on establishment of any industrial unit or infrastructure within at least 50 yards of the Buriganga River;
- Ban hanging latrines on the bank of the river;
- Ban the linking sewer lines with the river;
- Ban the disposal of solid wastes into the river;
- Remove wholesale and storage facilities from the river bank;
- Introduce proper waste management from floating restaurants and riverine vessels;
- Encourage proper treatment of industrial, hospital and clinical wastes;
- Encourage industries, factories, laboratories and workshops to undertake on-site treatment and to minimize wastes as far as possible; and
- Encourage the participation of the private sector, NGOs and community organizations and groups in various components of the BRCP, such as awareness building, mobilizing public support for an action and educating the general public.

Community Participation

Many of the existing development policies, particularly in the water sector, were conceived by donor agencies without any stakeholder participation. The policy formulation process as a whole is heavily 'top-down'. Lack of community participation is generally a missing component in the planning process in Bangladesh. Generally, there is neither any procedure for nor any tradition of the intended beneficiaries or affected people being consulted while designing any development projects. The ECVM can fill this gap. As Hamilton (1993) states that "[t]o make good decisions on the use of the natural environment, it is vital to have evidence on the value people attach to the environmental amenities of public resources. Traditionally, the valuations of the community have entered into government decisions only indirectly. The contingent valuation method goes directly to the community" (p: iii). The ECVM permits local residents to express their interest in the programme's components and to have some voice in the design and implementation of the programme. Thus, the ECVM can provide one form of community participation.

Besides allowing for the integration of benefits, including non-market goods and services, into the decision-making process, this study also reveals how the above measures can be taken in relation to the implementation of the BRCP. If this is done, the river will stand a better chance, which will benefit everybody.

7.2.2 Improving the Investment Decision Making in Bangladesh

Investing for the cleanup of the Buriganga River is, in the end, a political question and a matter of whose interests are to prevail in the decision making. An improvement to the present project appraisal system would be an incorporation of the more fully accounted values of resources as shown by the research in this study. The application of the ECBA, outlined here, can provide a useful complement to the other influences on the political process by clarifying what choices yield the highest net benefits to society. This can prevent political pressures which often direct resources away from their economic-optimum pattern of allocation and can aid in deciding upon the best use of finite investment resources.

Seen in that light, ECBA can be a useful 'watchdog' mechanism, which can provide a desirable means of limiting rent-seeking behaviour and coterie interest in Bangladesh. However, ECBA should not necessarily decide policy questions but should instead be one part of the overall decision-making process through integrating environmental considerations.

7.3 Contribution of the Research

Contribution of the research to knowledge and the policy-making field is discussed in this section.

7.3.1 Contribution to Knowledge and Theory

This research contributes to the development of knowledge and theory in two broad ways. First, it has developed a new methodological concept for valuing the environment, and, second, the new methodological framework has been applied to resolving a particular highly important practical problem in Bangladesh. These two points are expanded below.

Methodological Development

An important question to be answered now is: 'what research implications in terms of methodology can be gained from this study?' An extension to the conventional contingent valuation method was proposed and examined in this research. Rather than just asking respondents whether they would or would not be willing to pay a stipulated amount for a proposed cleanup programme, the new approach adds a follow up question asking if they would be willing to contribute their time or effort. This raises the aggregate payment amount (contribution) irrespective of the earlier decision whether to contribute cash money or not.

The application of the ECVM reveals that individuals are willing to pay significant portions of their income on goods and services related to environmental quality improvement and others are willing to contribute considerable time and effort to obtain environmental improvements. The monetary value of such efforts should be reflected in WTC estimates, whenever feasible.

This ECVM provides important information to improve the quality of decision making. The application of this ECV technique can make an important contribution to public policy formulation and analysis and results in better resource allocation and outcomes in the protection and development of natural resources.

Although the ECVM has been developed in the context of developing market economies, there is nothing to preclude its application in developed countries. A potentially positive outcome would be strengthening of the links with the environment and community development which contributes to sustainability.

This study also extended the conventional CBA through integrating non-market benefits including respondents' contribution in terms of time in the decision-making rule. The ECBA reveals that funding for the BRCP is worth undertaking. The application of the ECBA can be an important input for the decision rule in environmental improvement which is normally under-funded due to the fact that the many of the benefits are non-marketed.

Therefore, the case study reveals that the ECVM is capable of providing acceptable benefit estimates for a wide range of environmental improvements in developing countries. Also, a methodological development has been made in the field of project economic analysis through integrating environmental dimensions into the decision making.

A Framework for the Cleanup of Dying Rivers

The research results clearly imply the need for well-defined river management policies, particularly adjacent to cities and towns. Given the residents' high appreciation of non-market benefits of development and restoration of a dying river, it is worth introducing a new approach that is currently absent in the development process in Bangladesh. Non-market benefits are hardly appreciated in the planning and decision-making process. This needs to be changed.

When possible, the application of the new approach will help recognize the non-market goods and services associated with the cleanup of rivers and can provide important information to decision makers in selecting optimal resource allocation.

In the case of the Buriganga River, half of the expected benefits of the cleanup programme are marketed. The large share of market benefits is due to high land value in the study area, cost saving for domestic and industrial water use and potential health benefits of the BRCP. However, in the case of other rivers, the share of marketed to the total benefits might be very small. In that case, the cleanup may invariably appear to be 'non-economic'. This study reveals that the whole range of benefits, both market and non-market, is relevant to economic analysis. The use of direct benefits alone to determine investment worth is in fact a purely commercial criterion. Therefore, the benefits of cleanup programmes should be measured as the sum of all the components of TEV.

Currently, very limited data are available for surface water quality on a watershed scale in Bangladesh. A national water quality assessment programme is needed to assess the quality of all surface and ground water sources.

Controlling the various non-point sources of pollution is much more complicated. Since such sources of pollution are more difficult to identify, it becomes problematic to control their discharge into rivers. Proper sampling techniques and long-term monitoring of water quality at carefully selected locations can help to delineate the sources of such diffuse pollution. The best way to control non-point sources of pollution, however, is through education, awareness building among citizens about possible sources of such pollution, and implementation of 'best management practices'. The ECV survey can help the formulation of such policies. In addition, if implemented, the BRCP would contribute to building knowledge and encourage community contribution, ownership and responsibility for environmental improvement.

With proper policies, laws, regulations and acts and their strict enforcement, the point sources of pollution in a watershed can be controlled. An inventory of all toxic and hazardous chemicals that are produced, used and discharged by every facility (e.g. industry, factory, workshop and laboratory) needs to be prepared for all watersheds in Bangladesh.

Currently, many countries across the globe lack a proper mechanism for natural resource management in general and the cleaning up of polluted rivers in particular. Specifically, developing countries face severe environmental degradation which threatens to undermine their long-term development prospects. Natural resources are being used wastefully and in ways that foreclose options for development in the future. Patterns of investment – especially in water quality improvement or cleaning up rivers – rely heavily on inefficient use of resources while industrial noxious emissions and effluents, as well as other forms of pollution, go largely unchecked. This also creates problems that future generations will find costly and even impossible to resolve.

The framework designed for the cleanup of endangered rivers aims to change the current disintegrated and *ad hoc* nature of river restoration activities by providing a process that incorporates the variety of benefits in its decision-making calculus.

Given the positive estimates for the WTC that this study has revealed, there are untapped public funds and resources that could make this sustainable management potentially possible. Cleaning up the river entails high costs, but this study reveals that the cost can also be mobilized from within the community. In that case, estimates of a monetary value for the cleanup programme can be used in policy decisions.

The purpose of the ECV survey is to review the potential of this valuation technique as a means of providing useful information for policy decisions. Without such information on restoration importance to all of the community, public funds could not be committed to the cleanup of polluted river systems. This is evident as the allocation of public funds for such public goods is insufficient. The Government is currently facing a similar problem of deciding what resources should be allocated to protect waterways and how to finance such undertaking. The framework developed for the cleanup of the Buriganga River might be an important guide in this regard.

7.3.2 Contribution to Policy-making Field

The case study designed for this research has included in-depth sectoral and macro analyses. They can provide important inputs in the areas of project selection, resource allocation, policy formulation, integrated urban planning, the financing mechanism and benefit transfer. These are discussed below.

Better Project Selection

In the absence of systematic selection criteria, projects in Bangladesh are chosen on political grounds (political in the sense of narrow coterie interest). The CBA is an aid in allocating resources towards the projects with the largest gain for society (i.e. highest present value of net benefits). The application of the ECVM and ECBA can help to improve the selection of projects and programmes with net positive benefits. Eventually it will help to prevent destruction of natural resources. The ECVM provides important information to improve the quality of decision making.

Redirection of Resource Allocation

A systematic application of ECVM and ECBA is particularly useful in identifying not only the very good but also the very bad projects, that is, those projects where the costs of a wrong decision are high. Examples of wetland resources and open space were provided. More evidence can be found where the lack of a systematic weighing results in massive natural resource destruction.

Policy Formulation

The research is thus of direct and immediate relevance not only to the policy-making field in Bangladesh, but for the purpose of operationalizing the concept of sustainable development at the micro level globally. Non-market valuation studies can provide useful information to assist policy makers, planners and project analysts in making decisions in the areas of: (i) setting priorities; (ii) choice of service level; (iii) tariff design; and (iv) project design.

Integrated Urban Planning

The problems of the Buriganga River highlight a crisis of urban governance. Both market and policy failures are responsible for the deteriorating conditions of the river. The design of the BRCP provides a framework for integrated urban planning in which issues such as solid waste management, wastewater treatment, sewerage disposal, tourism and recreation and public health can be planned in an integrated, participatory and sustainable manner. Seen from this perspective, the BRCP experience can be replicated in other urban settings.

Financing Mechanism

Revenue-generating public utility institutions continue to face problems of cost recovery in Bangladesh. Water supply and solid waste management are some examples of such cases. Properly conducted ECV studies can clearly demonstrate the existence of potential cost recovery for utility services. These results indicate that there is potential revenue available for the Buriganga River cleanup from the community which could be tapped by the Government through appropriate mechanisms. Substantial public funds are potentially available to protect and enhance the environmental value of the resources. If compared to the cost estimates for the Buriganga River cleanup programme, the estimated households' willingness to contribute for improved environmental quality is adequate to cover the total investment needed. This fund (cost of the cleanup) can be generated from the community by framing an appropriate payment mechanism.

Like the Buriganga River, many other rivers and resources (e.g. historical sites, national parks and heritage buildings) are subject to destruction and their preservation and restoration are under-invested. The ECV study for the Buriganga River reveals that people are willing to contribute despite most of them being extremely poor. Many are willing to contribute not only in monetary terms, but also in terms of time. This is an important innovation in the ECV survey conducted for this study.

Lack of funds for the river cleanup and management is a global phenomenon, not only the case in developing countries. As Sanders *et al.* (1990) state that "[n]ations throughout the world face almost similar problems of how much they can afford to pay for river protection" (p: 1345). Application of the ECVM can demonstrate how investable funds can be generated from the community.

Benefit Transfer

The study uncovers considerable amounts of information about people's attitudes, perceptions and their willingness to contribute to the environmental improvements in their neighbourhood. Monetary values obtained from this particular valuation study can be transferred to any alternative or secondary policy decision setting in another geographical area both in Bangladesh and in other countries. Due to time and financial constraints of doing original valuation studies, this technique, known as *benefit transfer*, has become popular in recent years (Navrud and Pruckner, 1997). This study is significant and important in that it has generated some new and original results in a field characterized by an extreme dearth of rigorous applied research, particularly in the developing country context. Estimates of a monetary value for a river cleanup programme and information about attitudes towards restoration and development of a dying river can be used in policy decisions.

Therefore, this study makes an important contribution to the policy-making field providing some inputs which can be put in place to solve environment problems beyond the particular example set in this thesis.

7.4 Suggestions for Further Research

In *Chapter One*, the scope of the study has been outlined. It indeed provides an indication of the limitation of the thesis. The analysis has been carried out based on certain assumptions, described in *Chapter Six*, which inevitably limit the range of applicability of the results. Therefore, further research is required to examine what will happen if one or some of the assumptions are relaxed or are not met. Suggestions for further research are targeted into three areas: (i) specific to research methods; (ii) specific to the Buriganga River, the case study of this thesis; and (iii) application to other sites.

7.4.1 Specific to Research Methods

Although the sample of the ECV survey was split into two sub-samples (e.g. BRA and OBA), only one version of the questionnaire was designed for both these groups. Also, only one version of bid value (i.e. payment card) was used. A split sample with different versions of the questionnaire (e.g. one version of questionnaire randomly assigned to one sub-sample group) could have been used to examine whether (i) opinion varies with sample group, and (ii) opinion varies with payment option. Dichotomous choice format was not used, although many, including the NOAA Panel recommend the use of this format. One version of the questionnaire could be based on the dichotomous choice format. In this study only one scenario was specified, although in many studies more than one scenario was designed (see, for example, Imber *et al.,* 1993 for the study of the Kakadu Conservation Zone in Australia where the contingent scenario has been designed for major and minor changes). Two or more scenarios could have been developed and used among the respondents, dividing them accordingly.

Sensitivity analysis was carried out at a limited level. It could be extended. For instance, an area of analysis could be whether or not a household's WTC will increase proportionally if monthly household income increases by a certain proportion.

This research has emphasized the extension of standard CVM techniques in order to apply them in a developing country such as Bangladesh and the results of undertaking the adjusted survey, both in terms of sample characteristics and of a check for theoretical validity. It also reported the implications of the survey results for policy choice. The ECVM could be used in developed countries to see the effect of contribution of time or other mechanism of contribution.

7.4.2 Specific to the Buriganga River

Despite the effort to identify both point and non-point sources of pollution, it was not possible to determine the pollution load discharged into the Buriganga River. A scientific study would be in a position to estimate such figures. A study on the assimilative capacity of the river can help to determine the pollution load, i.e. receiving pollution load to the point where it could self-purify. Further technical studies are needed to investigate the regeneration capacities of the river.

7.4.3 Application to Other Sites

Being a lower riparian country within a large basin (i.e. GBM Basin) and a new delta, rivers play a very important role in Bangladesh. Many of the rivers in the country including the other five rivers surrounding Dhaka City are vulnerable now to a varying degree. Many of these rivers are the lifeline of one or more cities or towns (e.g. Karnaphuli River for Chittagong and Surma River for Sylhet). These rivers also need immediate action in the form of a cleanup programme, in line with the BRCP. Both the methodological innovation (i.e. ECVM and ECBA) and detailed design of the BRCP can be replicated for formulating the cleanup programmes of other rivers in order to examine their applicability and plausibility.

7.5 Final Comments

This research work attempts to fill in some specific gaps in the areas of economic valuation of non-market goods and services with respect to development projects and integration of those values in the policy decision-making process. The concept and theory of non-market valuation and project appraisal are examined in order to assess their applicability in the developing country context. In order to do so, the conventional contingent valuation approach is extended in that in addition to being asked to express their willingness to contribute money, respondents are also asked to state their willingness to contribute in terms of time. The value generated by the new approach (the extended contingent valuation method) is integrated into an extended cost-benefit analysis which reveals that the cleanup of the Buriganga River is worth undertaking. Apart from the theoretical investigation, another important dimension of this research is to locate and fill some gaps in the policy decision-making process in Bangladesh with regard to public sector investment.

Therefore, the extended contingent valuation survey is capable of estimating economic values of resources even in extremely poor economies. Nevertheless, the method needs appropriate modification taking into account local context including cultural, economic, social and political settings. An extended cost-benefit analysis integrating the fully accounted values of resources could thus provide important information in the policy decision-making process, particularly in countries where the democratic system is not adequately developed. Most importantly, it has the potential to contribute for improving environmental quality and local and regional sustainability.

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APPENDICES

Appendix I: List of offices visited for data and information collection

Academy for Planning and Development (APD)
Association of Development Agencies in Bangladesh (ADAB)
Asian Development Bank (ADB), Dhaka Office
Asiatic Society of Bangladesh
Bangladesh Bureau of Statistics (BBS)
Bangladesh Council of Scientific and Industrial Research (BCSIR)
Bangladesh Centre for Advanced Studies (BCAS)
Bangladesh Environment Lawyers' Association (BELA)
Bangladesh Inland Water Transport Authority (BIWTA)
Bangladesh University of Engineering and Technology (BUET): Department of Civil Engineering and Environment; Department of Drainage, Irrigation and Water Resources; and Department of Planning.
Bangladesh Paribesh Andolon (Bangladesh Environmental Movement/BAPA)
Bangladesh Unnayan Parishad (Bangladesh Development Council/BUP)
Bangladesh Water Development Board (BWDB)
Centre for Urban Studies (CUS)
Department of Environment (DOE)
Department of Fisheries
Department of Shipping (DOS)
Dhaka Chamber of Commerce and Industry (DCCI)
Dhaka City Corporation (DCC)
Dhaka University : Department of Geography and Environment
Dhaka Water and Sewerage Authority (DWASA)
Economic Relations Division (ERD)
Engineers' Institution – Bangladesh (EIB)
Goethe Institute, Dhaka
International Union for Conservation of Nature and Natural Resources (IUCN) – Bangladesh
Implementation Monitoring and Evaluation Division (IMED)
Local Government Engineering Department (LGED)
Ministry of Environment and Forest (MOEF)
Ministry of Finance (MOF)
Ministry of Industries (MOI)
Ministry of Local Government, Rural Development and Cooperatives (MOLGRDC)
Ministry of Shipping (MOS)
Ministry of Water Resources (MOWR)
National Board of Revenue (NBR)
Office of the Bangladesh Finished Leather and Leather Goods Exporters' Association

Planning Commission (PC)

Planning Division, Ministry of Planning

Poribesh Rokkha Shopoth (Pledge to Protect Environment/POROSH)

PROSHIKA (an acronym of three Bengali words, which stand for training (proshikkhan), education (shikkha) and action (karmo) and one of the largest NGOs in Bangladesh)

Rajdhani Unnayan Kartripakhya (Capital City Development Authority/RAJUK)

River Research Institute (RRI)

Social Science Research Council (SSRC)

Surface Water Modelling Centre (SWMC)

Waste Concern (WC)

Water Resource Planning Organization (WARPO)

Appendix II: Details of selected thanas, wards and mohallas for the survey

Name of Thana	**Ward Number**	**Name of Mohallas**
Lalbagh	62	Azimpur Philkhana Road and Lalitmohan Das Lane
	64	Palashy and Bakshi Bazar Road
Mohammadpur	14	Lalmatia and Humayun Road
	15	Bachila and Paschim Katasur Jafrabad
Sutrapur	37	Thatary Bazar and Wari
	41	Lalmohan Shaha Street and Tipu Sultan Road
Dhanmondi	17	Hazaribagh and Jhigatola
	20	Dhaka College, Elephant Road and Science Laboratory
Gulshan	72	Chairman Bari and Gulshan Uttar-Paschim
	74	Dakshin Badda and Purba Merul
Ramna	66	Malibagh and Wireless
	65	Eskaton and Magh Bazar
Sabujbagh	53	Rajarbagh and Sabujbagh
	56	Purba Goran and Uttar Goran

Appendix III: Sampling frame

(English translation from Bengali)

Set-A
(ONLY FOR THE USE OF INTERVIEWERS)

LIST OF HOUSEHOLD

Start listing all households from the north-west corner of a mohalla. After completing the listing, every 20th household should be selected for the survey and one adult member should be chosen from the selected household for an interview (with the help of set B and C). If nobody is found after three consecutive visits in three different days, select a backward or forward household respectively as a replacement sample. If nobody is found either in the selected or in the backward or in the forward household, then move forward and select 20th household as usual. This process will be continued until the required number of respondents from a mohalla are interviewed.

Serial numbers on the household list and contact sheet should be the same.

<table>
<tr><td colspan="4">Thana: Ward: Mohalla:</td></tr>
<tr><td colspan="4">Serial no- 01</td></tr>
<tr><td>Interview from selected household</td><td></td><td>Nobody found in the selected household</td><td></td></tr>
<tr><td>Interview from backward household</td><td></td><td>Nobody found in the backward household</td><td></td></tr>
<tr><td>Interview from forward household</td><td></td><td>Nobody found in the forward household</td><td></td></tr>
<tr><td colspan="4">Serial no- 02</td></tr>
<tr><td>Interview from selected household</td><td></td><td>Nobody found in the selected household</td><td></td></tr>
<tr><td>Interview from backward household</td><td></td><td>Nobody found in the backward household</td><td></td></tr>
<tr><td>Interview from forward household</td><td></td><td>Nobody found in the forward household</td><td></td></tr>
<tr><td colspan="4">Serial no- 03</td></tr>
<tr><td>Interview from selected household</td><td></td><td>Nobody found in the selected household</td><td></td></tr>
<tr><td>Interview from backward household</td><td></td><td>Nobody found in the backward household</td><td></td></tr>
<tr><td>Interview from forward household</td><td></td><td>Nobody found in the forward household</td><td></td></tr>
</table>

Serial no- 04			
Interview from selected household		Nobody found in the selected household	
Interview from backward household		Nobody found in the backward household	
Interview from forward household		Nobody found in the forward household	
Serial no- 05			
Interview from selected household		Nobody found in the selected household	
Interview from backward household		Nobody found in the backward household	
Interview from forward household		Nobody found in the forward household	
Serial no- 06			
Interview from selected household		Nobody found in the selected household	
Interview from backward household		Nobody found in the backward household	
Interview from forward household		Nobody found in the forward household	
Serial no- 07			
Interview from selected household		Nobody found in the selected household	
Interview from backward household		Nobody found in the backward household	
Interview from forward household		Nobody found in the forward household	
Serial no- 08			
Interview from selected household		Nobody found in the selected household	
Interview from backward household		Nobody found in the backward household	
Interview from forward household		Nobody found in the forward household	
Serial no- 09			
Interview from selected household		Nobody found in the selected household	
Interview from backward household		Nobody found in the backward household	
Interview from forward household		Nobody found in the forward household	

(Continued ……………….)

Appendix IV: Contact sheet

(English Translation from Bengali version)
Set-B

Serial No:
Code No:
(IF THE RESPONDENT HAS AGREED TO BE INTERVIEWED, ONLY THEN FILL IN CODE NUMBER ON THE CONTACT SHEET AND INTERVIEW SCHEDULE. BOTH CODES SHOULD BE THE SAME.)

CONTACT SHEET

Assala mu alai kum. My name is -----. We are conducting a survey about the state of the environment in Dhaka City and an economic analysis of environmental quality improvement. This survey is part of a Bangladesh student's PhD research in an Australian University. I would be very grateful if you could help me in doing this survey.

According to random sampling, your household has been selected as a sample for this survey. I would like to interview an adult member of your household to be selected randomly. I guarantee that all the information the respondent will give me will be kept confidential and there is no relation between this survey and any policies of the Government. The questionnaire will take about 30 minutes. Again, I assure you of the complete anonymity and confidentiality of your responses.

Q-A: Please tell me whether you agree for your household to participate in this survey?

1 [ ] Yes (IF AGREES, FILL IN Q- B AND D AND START SURVEY)
2 [ ] No (IF DOES NOT AGREE, SKIP TO QUESTION E AND NEXT)

Q-B: I need to select for my survey one mature person at random from your household who is 18 years old or more and mentally and physically fit. Please tell me the nick names of all the adult members who usually live in your household. Let's start with the oldest person.

No	Nick name	No	Nick name
1		6	
2		7	
3		8	
4		9	
5		10	

(ENLIST ALL ADULT MEMBERS OF THE HOUSEHOLD. WITH THE HELP OF THE **RANDOM NUMBER TABLE**, SELECT ONE RESPONDENT. IF RESPONDENT AND CONTACT PERSON ARE THE SAME, START INTERVIEW IF S/HE AGREES OR OTHERWISE ARRANGE A TIME FOR THE INTERVIEW. IF RESPONDENT IS OTHER THAN THE CONTACT PERSON, CONTACT HER/HIM. GIVE THE BACKGROUND INFORMATION AND THEN ASK THE FOLLOWING QUESTIONS).

Q-C: You have been selected randomly from your household for this survey. Do you agree for an interview now?

1 [ ] Yes (IF AGREES, FILL IN Q-D AND START INTERVIEW)
2 [ ] No (IF DOES NOT AGREE, SKIP TO Q-E AND NEXT)

Q-D: NUMBER OF VISIT(S) TO THIS HOUSEHOLD FOR AN INTERVIEW (FOR USE OF INTERVIEWER)

No of visits	Date and time	Comments	Contact address
First			
Second			
Third			

Q-E: You did not agree to participate from your household to be interviewed in this survey. Could you please tell me the reason?

1 [ ] The respondent is absent
2 [ ] No financial incentive
3 [ ] Scared to speak to unknown person
4 [ ] No-confidence about outcome of such survey
5 [ ] Lack of time
6 [ ] Others (please specify):

Question- F: To which age group do you belong?

1 [ ] 18-25 years
2 [ ] 26-35 years
3 [ ] 36-47 years
4 [ ] 48 years and more
5 [ ] Refuse/Don’t wish to disclose

Q-G: What is your occupation: ....

Appendix V: Random number table

No of adult members	Respondents to be selected
1	1 1 1 1 1 1 . . . . .
2	2 1 1 2 2 1 2 1 2 1 2 1 1 1 2 1 2 2 1 2 2 2 1 2 2 1 1 2 1 1
3	1 3 3 3 3 1 1 1 2 2 2 3 2 1 3 1 3 2 2 1 2
4	3 2 2 1 4 4 4 2 3 1 1 3
5	1 4 3 5 3 4 5 2 1 2
6	6 3 1 5 4 2
7	3 5 2 7 1 4 6
8	5 4 2 7 1 6 8 3
9	5 4 2 7 1 6 8 3
10	3 6 10 4 5 2 1 8 6 9
> 10	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 ……

Appendix VI: Response rate

(a) Total houses visited	470
(b) Nobody found after three visits	17
(c) Contact persons refused to participate in the survey	12
(d) Contact persons agreed for their household's participation in the survey	441
(e) Contact persons themselves respondents and did not agree to be interviewed	14
(f) Contact persons themselves respondents and agreed to be interviewed	194
(g) Interview completed First visit: 132 Second visit: 33 Third visit: 9	174
(h) Fail to interview after three visits	20
(i) Respondents other than contact persons and did not agree to be interviewed	7
(j) Respondents other than contact persons and agreed to be interviewed	226
(k) Interview completed First visit: 107 Second visit: 76 Third visit: 3	186
(l) Fail to interview after three visits	40
(m) Replacement sampling	111
(n) Replacement sampling successful	40
(o) Total survey completed	400
(p) Response rate (400/470*100)	85.10

Appendix VII: Full version of interview schedule

(English translation from Bengali)

(Confidential)
Set-C

Name of Interviewer: ……………………………..
Date: ……………… Place of Interview: ………………………...
Time: …………. to …………….
Thana: …………………. Ward: ……………
Street: …………………. House: …………

Code No:

INTERVIEW SCHEDULE

I am going to ask you some questions about your perceptions about environmental problems in Dhaka City and the way you want to see them addressed. The main purpose of this survey is to understand what environmental improvements you want to see and how could they benefit you and your family.

It is important for us that you answer the questions as truthfully and honestly as you can. There is no right or wrong answer. It is your opinion, will, knowledge, attitudes, and expectations that count in understanding some pressing issues the city dwellers are now facing and finding out how respondents like you value the benefits of environmental improvements in your neighbourhood.

For each question, please provide the response(s) which best reflect(s) your opinion. Please, follow the instruction as to whether single or multiple responses are allowed. Your answers will be completely confidential and will not be used for any other purposes than a PhD research at an Australian university.

(UPPERCASE LETTERS ARE FOR INTERVIEWERS. TICK APPROPRIATE BRACKET WHERE APPLICABLE.)

Section-A

A.1 How would you rank Dhaka generally as a place to live?

1	[ ] Excellent	4	[ ] Poor
2	[ ] Good	5	[ ] Terrible
3	[ ] Neither good nor poor	6	[ ] Don't know

A.2 Please, select from the list below the five most urgent environmental problems in Dhaka City which you would like immediately addressed. Please, rank their *urgency between 1 and 5; 1 meaning extremely urgent, 2 very urgent, 3 considerably urgent, ………… and 5 urgent***.**

		Rank
1	Air pollution	
2	Traffic congestion	
3	River and water pollution	
4	Unhygienic/inadequate disposal of wastes	
5	Noise pollution	
6	Inadequate/untreated water supply and sewerage disposal	
7	Odour from waste, garbage, dustbin etc.	
8	Others (specify):	

A.3 *Most of the boundary of Dhaka City is surrounded by rivers. Would you please tell me the name of river(s)?*

	Rivers	**Tick**		**Rivers**	**Tick**
1	Buriganga		5	Balu	
2	Turag		6	Tongi	
3	Sitilakhya		7	Others	
4	Dhaleswari			Don't know	

A.4 Have you ever visited the Buriganga Riverside? If yes, how many times have you visited the Buriganga River in the ***last three years****?*

1 [ ] Once
2 [ ] 2-5 times
3 [ ] 6-10 times
4 [ ] More than 10 times
5 [ ] Can't remember
6 [ ] Never visited (SKIP TO A.6)

A.5 What was the main purpose of your visit(s)?
(MULTIPLE ANSWERS ARE ACCEPTED)

1 [ ] Navigation
2 [ ] Recreation (e.g. boating and fishing)
3 [ ] Swimming, washing and bathing
4 [ ] Collection/use of river water for household and commercial purposes
5 [ ] Commercial fishing
6 [ ] Business
7 [ ] Shopping and marketing
8 [ ] Others (specify):

A.6 What is the distance in kilometers from your house to the nearest site of the Buriganga River? (RECORD, IF POSSIBLE)

1 [ ] Less than one km
2 [ ] 1 to 2 km
3 [ ] >2 to 5 km
4 [ ] >5 to 10 km
5 [ ] More than 10 km
6 [ ] Don't know

A.7 Are you concerned about the state of the Buriganga River?

1 [ ] A great deal
2 [ ] A fair amount
3 [ ] Not very much
4 [ ] Not at all
5 [ ] Don't know/refuse to answer

A.8 Choose the option which you think best describes the water quality of the Buriganga River?
1 [ ] Extremely bad
2 [ ] Bad
3 [ ] Not bad not good
4 [ ] Good
5 [ ] Very good
6 [ ] Don't know/refuse to answer

A.9 What makes you concerned regarding the state of the Buriganga River? (MULTIPLE ANSWERS ARE ACCEPTED)
1 [ ] I am not concerned
2 [ ] Water pollution
3 [ ] Illegal encroachment
4 [ ] Untreated waste and sewerage disposal into the river
5 [ ] Closure of recreational facilities
6 [ ] Loss of natural beauty
7 [ ] Too much navigation
8 [ ] Lack of fish and other aquatic resources
9 [ ] Loss of navigability and water flow
10 [ ] Others (specify):
11 [ ] Don't know/refuse to answer

A.10 To the best of your knowledge, what causes the degradation of water quality in the Buriganga River? (MULTIPLE ANSWERS ARE ACCEPTED)
1 [ ] Nothing is impacting seriously, the water in the river can take it
2 [ ] Untreated industrial effluent into river
3 [ ] Pollution from mechanized riverine vessels
4 [ ] Untreated garbage and sewage disposal into the river
5 [ ] Lack of enforcement of law regarding discharge of wastes into rivers
6 [ ] Illegal encroachment
7 [ ] Others (specify):
8 [ ] Don't know/refuse to answer

A.11 Do you think that the water quality in the Buriganga River can cause the following effects? (MULTIPLE ANSWERS ARE ACCEPTED)
1 [ ] No effect
2 [ ] Health problems
3 [ ] Closure of recreational sites
4 [ ] Loss of earnings
5 [ ] Water crisis
6 [ ] Flooding
7 [ ] Others (specify):
8 [ ] Don't know/refuse to answer

Section-B

B.12 How do you want to see the environment surrounding the Buriganga River?
1 [ ] As it is (SKIP TO B.14)
2 [ ] Improved (SKIP TO B.13)

3 [ ] Don't know/refuse to answer (SKIP TO B.14)

B.13 If you want to see improvements, what are your top four priorities? Please rank between 1 and 4;1 meaning extremely urgent, 2 very urgent, 3 considerably urgent, and 4 urgent.

		Rank			Rank
1	Eviction of illegal settlements		6	Dredging of riverbed	
2	Setting treatment plant for industrial, hospital and household wastes		7	Closure of sewer lines into the Buriganga River	
3	Control of pollution from riverside industry and commercial activities		8	Control of pollution from mechanized riverine vessels	
4	Legitimization of existing settlements		9	Formulation and implementation of strict laws	
5	Make footpaths and roads, and tree plantation along the river bank		10	Others (specify):	

B.14 Which of the following facilities/amenities you want to use in future, if these are restored or established in and around the Buriganga River? (MULTIPLE ANSWERS ARE ALLOWED)

	Amenities/facilities	Yes	No	Not sure
1	Water transport			
2	Use of river water for household and commercial purposes			
3	Picnic and recreation			
4	Swimming, boating and other water sports			
5	Visit heritage/historical sites on the riverside			
6	Fishing			
7	Jogging/walking along the river bank			
8	Access road to riverside			

Section-C

C.15 *I have designed a programme which could address the water quality and other environmental problems of the Buriganga River. If you are not convinced that the situation needs urgent intervention, do you want me to give you the details of such a programme?*

1 [ ] Yes, give me the details (GO TO THE DETAILED DESCRIPTION[1])

2 [ ] No, I am aware of the urgency (SKIP THE DETAILED DESCRIPTION AND GO TO C-16)

(READ FOR BOTH GROUPS)

Improvement of the Buriganga River would involve a lot of investment from the community, and I would like you to think that money would be raised through imposing a levy on water use and which will be collected along with the water bill. Please answer the following questions thoughtfully.

[1] Description of hypothetical scenario is presented in *Appendix IX*.

C.16 If a cleanup programme for the Buriganga River is undertaken, would you support this programme?

1 [ ] Very strongly support (SKIP TO C.18)
2 [ ] Strongly support (SKIP TO C.18)
3 [ ] Support somehow (SKIP TO C.18)
4 [ ] Not sure (SKIP TO C.18)
5 [ ] Don't support (GO TO C.17)

C.17 Why do you not support the cleanup programme which is associated with the overall environmental improvement of the City you live in?

1 [ ] It will cost money
2 [ ] Other reason (specify):
(GO TO C.22 AND ONWARDS)

C.18 Now I would like to know, whether you are willing to contribute money to improve the Buriganga River to an acceptable level so that swimming, fishing and boating are safe and it could be used for drinking after simple treatment?

1 [ ] Yes, I am willing to pay (GO TO C.19 AND ONWARDS EXCEPT C.21)
2 [ ] No, I am not willing to pay (GO TO C.21 AND ONWARDS)
3 [ ] Prefer not to vote on this issue (GO TO C.22 AND ONWARDS)

C.19 How much money are you willing to contribute as an increase in the water bill from your household budget ***monthly*** *for the proposed improvement* ***over a period of ten years****? Remember, you will be required to pay this amount in addition to your other regular taxes and this money will only be spent for cleaning up the Buriganga River. However, I assure you that nobody is going to ask you to pay the money right now. It is only to judge your willingness and ability to contribute money.*

1 [ ] > 2,000 Taka
2 [ ] 1,001 – 2,000 Taka
3 [ ] 501 – 1,000 Taka
4 [ ] 201 – 500 Taka
5 [ ] 101 – 200 Taka
6 [ ] 51 – 100 Taka
7 [ ] 1 – 50 Taka
8 [ ] Undecided
9 [ ] Refuse to answer

C.20 Why did you vote "Yes" i.e., why do you want to contribute money?
(MULTIPLE ANSWERS ARE ACCEPTED)

1 [ ] On the basis of the understanding that people should pay for the services they expected to be provided
2 [ ] Concerned about water quality in the Buriganga River
3 [ ] Government does not have enough money to invest
4 [ ] Satisfaction from knowing that the river is free from pollution and encroachment
5 [ ] Satisfaction from knowing that the river water may be used for future household needs including drinking either for own use or for heirs
6 [ ] Others (specify):

C.21 Why aren't you willing to contribute money for the cleanup of the Buriganga River?

(MULTIPLE ANSWERS ARE ACCEPTED)

1 [ ] Lack of confidence in the success of the proposed programme
2 [ ] Government's sole responsibility to create such facilities
3 [ ] Money may be misappropriated/misused
4 [ ] Don't have enough money to pay for such services
5 [ ] I am not a polluter, polluters should pay
6 [ ] Government should stop corruption and misuse, and reallocate money from less important programmes/sectors to this programme
7 [ ] Others (specify):

C.22 Would you be willing to contribute your own time to such a programme or is there any other way in which you could contribute to the cleaning of the Buriganga River regardless of whether you want to pay or not?

*(a) Please, specify the number of **hours per month** that you would be willing to contribute voluntarily? Remember, you will have to do this in your spare time.*

1 [ ] Don't want to contribute/unwilling to participate
2 [ ] Don't know/refuse to answer
3 [ ] < 1 hours per month
4 [ ] 1 – 4 hours per month
5 [ ] 5 – 12 hours per month
6 [ ] 13 – 48 hours per month
7 [ ] More than 48 hours per month

(b) If you are willing, what type of work would you want to participate in?

1 [ ] Physical labour
2 [ ] Campaign and public awareness building
3 [ ] Participate in meeting and rally
4 [ ] Participate in non-technical office work
5 [ ] Participate in technical office work
6 [ ] Consultancy
7 [ ] Others (Specify):

(c) Any other contribution you are willing to make? (WRITE IN)

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

C.23 In this hypothetical programme, the task of bringing about a real improvement in the lives of the people would need to be taken on by some authority or combination of bodies. Regardless of whether or not you personally support the programme or would want to pay for it, do you feel that it should be paid for mainly by…… (MULTIPLE ANSWERS ARE ALLOWED)

1 [ ] People directly involved as users of the improved goods (e.g. water) and services
2 [ ] People who live around the affected area as well as the riverside
3 [ ] People who benefit from the river indirectly (e.g. customers of tannery, people living in the downstream)

4 [ ] People and organizations not involved but remote (e.g. citizens from all over the country, Government, Donors and NGOs)
5 [ ] Others (Specify)

C.24 What should be the contribution in terms of percentage for various parties to such a programme? (CHECK WITH OTHER INFORMATION)

Parties	**Contribution (%)**
Government fund collected through existing taxes	
Special fund through new levy	
Donors	
NGOs/private sector	
Others (specify):	
Total	**100**
Refuse to answer/not sure	
Don't support the programme	

C.25 Who should be involved in the programme's implementation?

1 [ ] Govt departments
2 [ ] Private sector
3 [ ] NGOs
4 [ ] Govt and private sector
5 [ ] Govt and NGOs
6 [ ] NGOs and private sector
7 [ ] All
8 [ ] Others (specify):

C.26 The duration of the payment has been set for ten years. How long would you think is most appropriate?

1……… year(s)
2 [ ] Agree with the proposed duration
3 [ ] Don't know/refuse to answer

C.27 In the hypothetical programme, it has been proposed that money will be collected through imposing a levy on residents within Dhaka City for this programme. Do you agree with this payment mode or do you want to pay in another way? (MULTIPLE ANSWERS ARE ALLOWED)

1 [ ] Proposed special fund
2 [ ] Fines on polluters
3 [ ] Users' fee
4 [ ] Additional income tax
5 [ ] Others (specify):
6 [ ] Don't support the programme/not willing to pay

C.28 Do you want any commitment to save the Buriganga River from the candidates contesting in your locality in the coming local or national elections?

1 [ ] Yes 2 [ ] No

Section- D

Now I would like to ask you some demographic questions only to see how your opinions compared with those of other people.

D.29 What is your relationship with the head of the household?

1	[ ]	Head of household	3	[ ]	Children
2	[ ]	Spouse	4	[ ]	Others

D.30 RECORD RESPONDENT'S SEX(DON'T ASK)

1 [ ] Male 2 [ ] Female

D.31 What is the highest level of education you have obtained?

1 [ ] No schooling
2 [ ] Primary education (1 – 5 years)
3 [ ] Secondary education (6 – 10 years)
4 [ ] Higher secondary education (11 – 12 years)
5 [ ] Graduate degree
6 [ ] Postgraduate education
7 [ ] Don't wish to disclose

D.32 What is your main occupation?

1	[ ]	No work	7	[ ]	Construction
2	[ ]	Looking for job	8	[ ]	Transport and Communication
3	[ ]	Household work	9	[ ]	Business
4	[ ]	Agriculture	10	[ ]	Service
5	[ ]	Industry	11	[ ]	Others (specify):
6	[ ]	Water/Electricity/Gas			

D.33 Which income group best describes the total income of all members of your household from all sources for a month before tax or anything else is taken out? Please include all sources such as wages, salaries, income from agriculture, house rent and business, interest on savings accounts and so forth.

1 [ ] < Tk. 1,000
2 [ ] Tk. 1,000 – 2,000
3 [ ] Tk. 2,001 – 4,000
4 [ ] Tk. 4,001 – 6,000
5 [ ] Tk. 6,001 – 10,000
6 [ ] Tk. 10,001 – 20,000
7 [ ] Tk. 20,001 – 40,000
8 [ ] Tk. 40,001 – 100,000
9 [ ] More than Tk. 1,000,000
10 [ ] Don't know/wish to disclose

D.34 How would you describe your current marital status?

1 [ ] Never married
2 [ ] Currently married
3 [ ] Widowed
4 [ ] Divorced/separated
5 [ ] Refuse/don't wish to disclose

D.35 To which age group do you belong?

1 [ ] 18 – 25 years

2 [ ] 26 – 35 years

3 [ ] 36 – 47 years

4 [ ] 48 – 57 years

5 [ ] 58 years and more

6 [ ] Don’t wish to disclose

D.36 Including yourself, how many adult and minor members live in this household?

1 [ ] Number of adults (≥18 years) ------

2 [ ] Number of minors (<18 years) ------

D.37 Type of dwelling (wall material of main house) (RECORD, IF POSSIBLE)

1 [ ] Straw/bamboo/jute stick
2 [ ] Mud/unburnt brick
3 [ ] Corrugated Iron sheet
4 [ ] Wood
5 [ ] Cement/brick
6 [ ] Others (specify): …..........

D.38 How many years have you been living in Dhaka City?

Years…………

D.39 Please make some further comments you would like me to consider.

....
....
....
………………………………………………………………………………

D.40 If need be, can I contact you again for further information or can the researcher contact you for confirmation whether I have done my job properly?

1 [ ] Yes 2 [ ] No

If yes to either of above, would you please give me your contact address (including telephone number):

D. 41 Do you want to contact the researcher to know more about the research or any other issues in relation to this survey?

1 [ ] Yes 2 [ ] No

(IF YES, PLEASE PROVIDE THE CONTACT ADDRESS OF THE RESEARCHER)

(PLEASE SAY): Thank you for your Cooperation

Interviewer's observation (COMPLETE THESE QUESTIONS IMMEDIATELY AFTER THE INTERTVIEW):

A. Quality of interview (data)
1 [ ] Excellent
2 [ ] Alright
3 [ ] Poor
4 [ ] Very poor

B. How informed/aware did the respondent seems to be about water quality improvement in the Buriganga River?
1 [ ] Very well informed
2 [ ] Somewhat
3 [ ] Not very
4 [ ] Not at all informed

C. Which of the following descriptions best describe the degree of effort/interest the respondent made to arrive at a value for the Buriganga cleanup?
1 [ ] Careful and sincere consideration
2 [ ] Some consideration
3 [ ] Very little consideration
4 [ ] Did not pay any consideration

(*RECORD TIME IN THE FIRST PAGE)*

Interviewer's open comments:

Programme Components: Major components of the programme would be: ??

- policy formulation for the market to function well
- treatment plant for industrial effluents particularly for Hazaribag tannery
- proper disposal and treatment of solid waste
- removal of illegal encroachment
- creating recreation facilities along riverside
- regular dredging
- solid waste collection and treatment
- restoring and renovating heritage sites and places of interest
- mobilizing public resistance against river grabbing
- creating awareness among residents about civic norms

B.15 What is the main source of your household water?

1 [ ] Tap connection
2 [ ] Private tubewell
3 [ ] Dugwell
4 [ ] River/canal
5 [ ] Pond
6 [ ] Road-side tap connection
7 [ ] Others (specify):

B.16 What is the main source of your drinking water?

1 [ ] Tap connection
2 [ ] Private tubewell
3 [ ] Dugwell
4 [ ] River/canal
5 [ ] Pond
6 [ ] Road-side tap connection
7 [ ] Others (specify):

B.17 How do you consider your overall health condition?

• [ ] Very good
• [ ] Good
3 [ ] So so
4 [ ] Bad
5 [ ] Very bad

B.18 Did you and members of your family suffer from any of the following water-borne diseases over the ***last three years****? (IF YES, THEN PUT TICK MARK)*

Diseases	**TICK**	**Diseases**	**TICK**
Diarrhoeal		Trypanosomiasis or sleeping sickness,	
Dengue fever		Intestinal nematode infection (e.g., hookworm, roundworm)	
Dysentery		Malaria	
Jaundice		Schistosomiasis	
Typhoid		Skin diseases	

B.19 Which of these best describes your decision if the water of the Buriganga River is cleaned enough after an intervention for the use in future for household purposes such as washing, bathing, drinking etc.? (EXPLAIN THE TERM 'INTERVENTION')

1 [ ] Currently I use it for these purposes and I will continue to use
2 [ ] No, currently I do not use; but I want to use in future if cleaned up
3 [ ] No, currently I do not use, and I also do not want to use in future

4 [ ] Not sure

B.21 Of which of the following environmental improvement programmes recently undertaken by the Government for Dhaka City are you aware?
(MULTIPLE ANSWERS ARE ACCEPTED)

1 [ ] Buriganga cleanup programme
2 [ ] Circular waterways
3 [ ] Air quality improvement
4 [ ] Not aware of any of the above
5 [ ] Others (specify):

B.22 Do you have any of the following habit/hobby?
(MULTIPLE ANSWERS ARE ACCEPTED)

1 [ ] Fishing
2 [ ] Swimming
3 [ ] Jogging
4 [ ] Boating

C.33 Which of these best describes your decision about water quality improvement of Buriganga River?(CROSS CHECH WITH ABOVE INFORMATION)

1 [ ] Willing to pay, but not able
2 [ ] Able, but not willing to pay
3 [ ] Not able, not willing to pay
4 [ ] Able and willing to pay

D.46 Tenurial status of the house

1 [ ] Squatting
2 [ ] Renting from private landlord
3 [ ] Real estate apartment
4 [ ] Government quarter
5 [ ] Owned by the family
6 [ ] Others (specify):

File: Khorshed/InterviewSch

Appendix VIII: Full version of re-interview schedule

(English translation from Bengali)

(Confidential)

Date: ………………	**Code:**
Thana: …………………. Ward: ……………	
Street: …………………. House: …………	
Unit/Flat: …………………….	

RE-INTERVIEW SCHEDULE

My name is Khorshed Alam. Currently I am doing a PhD at Murdoch University in Australia. One of my research associates appointed to collect data for a survey on environmental problems in Dhaka City and the way you want to see them addressed interviewed you on -----. I am grateful to you for your participation in the survey. In order to assess whether the interviewer did his/her job properly as well as to examine the consistencies of the information provided by you, I would like to ask you few questions. About five minutes time is required to finish this task. I would be grateful to you if you could help me.

Whether or not you are willing to participate in the interview?

1 Yes [START INTERVIEWING]
2 No [STOP AND GO TO OTHER PARTICIPANT]

Q.1 RECORD RESPONDENT'S SEX (DON'T ASK)

1 [ ] Male 2 [ ] Female

Q.2 What is the highest level of education you have obtained?

1 [ ] No schooling
2 [ ] Primary education (1 – 5 years)
3 [ ] Secondary education (6 – 10 years)
4 [ ] Higher secondary education (11 – 12 years)
5 [ ] Graduate degree
6 [ ] Postgraduate education
7 [ ] Don't wish to disclose

Q.3 *Most of the boundary of Dhaka City is surrounded by rivers. Would you please tell me the name of river(s)?*

	Rivers	**Tick**		**Rivers**	**Tick**
1	Buriganga		5	Balu	
2	Turag		6	Tongi	
3	Sitilakhya		7	Others	
4	Dhaleswari			Don't know	

Q.4 Have you ever visited the Buriganga Riverside? If yes, how many times have you visited the Buriganga River in the ***last three years****?*

1 [ ] Once
2 [ ] 2 – 5 times
3 [ ] 6 – 10 times
4 [ ] More than 10 times
5 [ ] Can't remember
6 [ ] Never visited

Q.5 In order to save the Buriganga River from encroachment and pollution and for an overall environmental improvement, a hypothetical cleanup programme was proposed in the earlier interview. Could you remember whether you provided your support for this programme?

1 [ ] Very strongly support
2 [ ] Strongly support
3 [ ] Support somehow
4 [ ] Not sure
5 [ ] Don't support

Q.6 If you agreed to support the cleanup programme, then how much were you willing to pay as an increase in the water bill from your household budget ***monthly*** *for* ***a period of ten years****? Let me remind you again that you will be required to pay this amount in addition to your other regular taxes and this money will only be spent for cleaning up the Buriganga River. However, I assure you that nobody is going to ask you to pay the money right now. It is only to judge your willingness and ability to contribute money.*

1 [ ] > 2,000 Taka
2 [ ] 1,001 – 2,000 Taka
3 [ ] 501 – 1,000 Taka
4 [ ] 201 – 500 Taka
5 [ ] 101 – 200 Taka
6 [ ] 51 – 100 Taka
7 [ ] 1 – 50 Taka
8 [ ] Undecided
9 [ ] Refuse to answer

Q.7 The duration of the payment for the residents had been set for ten years. Could you please remember the duration you suggested while expressing your views in the last interview?

1……… year(s) 2 [ ] Agree with the proposed duration
3 [ ] Don't know/refuse to answer

Q.8 Do you want to contact me to know more about the research or any other issues in relation to this survey?

1 [ ] Yes 2 [ ] No

Thank you very much for your cooperation

Appendix IX: Description of the hypothetical scenario

(English translation from Bengali)

Let me take some time to describe to you what I want you to consider.

Existing situation: As you may be aware, the water of the Buriganga River is currently contaminated, and the bank of the river is continuously being encroached (SHOW PHOTO). Every day huge amounts of toxic effluents drain from unregulated, unauthorized industrial activities and untreated human excrement flows into the Buriganga River. The toxic wastes of the tanneries from Hazaribagh also flow freely into the river (SHOW PHOTO). Indeed, over the years, Buriganga has become a place to defecate, and empty sewage and place for disposal of other effluents. There is a genuine fear that if this process is not reversed, the day is not far off when the river, with a canal like appearance in the worst encroached sections, will just cease to exist.

Intervention: It is urgently required that the Buriganga River be cleaned up on an emergency basis. To respond to this call, I think that the Government should undertake the "Buriganga River Cleanup Programme" in order to remove illegal encroachment, make the river water clean and safe and allow various water activities (e.g. swimming and better navigation). Without such an intervention, there is a genuine fear that not only within a few years the Buriganga will be dead biologically and hydrologically, but also the deteriorating situation will pose a serious water crisis, health hazards and likelihood of flood in Dhaka City.

Another important issue is that the Buriganga River is considered as the lifeline of Dhaka City as it has been developed on its bank. It is not the only river surrounding Dhaka City. Dhaka is surrounded by five more rivers and all these rivers are subject to encroachment and pollution. "The Buriganga River Cleanup Programme" is important for:

- Centering on the Buriganga River, a framework of sustainable city development planning for Dhaka City is possible so that issues like sustainable river management, collection, disposal and treatment of solid waste, proper sewerage management, wastewater disposal and management, environment-friendly tourism, and preservation and restoration of cultural and heritage sites could be integrated in a holistic fashion.

- Experts claim that use of ground water in Dhaka City has exceeded a tolerable limit. Under this circumstance, the Buriganga River water could be a major source of water for household purpose as use of surface water becomes inevitable in future.
- Civil society initiatives and participation are very important to save rivers. Such initiatives have been demonstrated in the case of the Buriganga River.
- Government, private sector, NGOs, civil society, community organizations and leaderships, and local initiatives and experiences could be integrated and replicated elsewhere through implementing this programme.

Hypothetical scenario: The proposed programme might be aimed specifically to provide the following services and amenities:

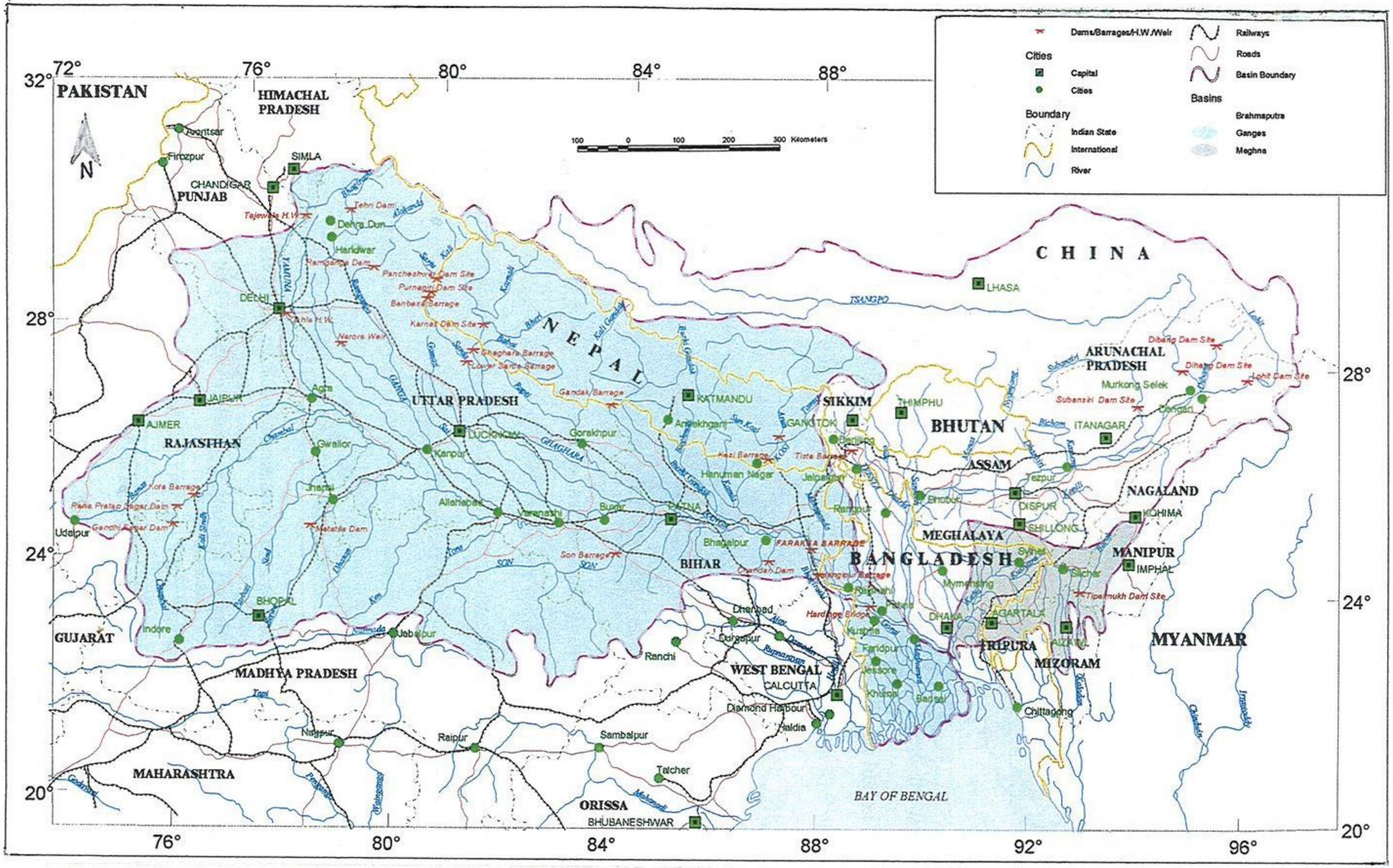
- ensuring safe and clean water in the river
- potential source of water for domestic and industrial uses
- removal of illegal encroachments
- disposal of wastewater from sewers and drains, and industrial effluents into the river subject to proper treatment
- better water transport
- tree plantation, construct sheds and benches at the bank of the river
- road (access) communication
- reduced incidence of flooding through regular dredging and river training
- increased fish production in the river
- preservation of historical and heritage sites on the riverside
- create an environment for swimming, other water activities and tourism
- restoration of aesthetic beauty.

Extent of water quality improvement: However, considering the present level of ambient water quality in the Buriganga River, a question might be raised about the extent to which the improvement would take place. In this survey, water quality improvement has been specified as a change from the existing level to a certain level of improvement where individuals could use the river water for swimming, fishing and boating. Most importantly, regulations would be established so that none can either grab the river or use it beyond its carrying capacity. Upon proper implementation of the proposed programme, it is expected that the use of river water for household and industrial purposes will be possible. It is also possible that reliable, clear and clean drinking water can be prepared using simple methods of treatment by the end of this programme. It may be mentioned here that this is a continuous type of programme. After the major capital investment, recurring investments will be required for maintenance and renovation.

Financing the Programme: The Government can engage in such restoration and development activities only if extra funds are generated and, most importantly, if people are really willing to participate in the implementation of such a programme and are willing to pay for part of its expenditure. Currently the Government does not levy any amount of money for environmental improvement. I will thus request you to imagine a hypothetical situation where the Government is going to introduce a levy on water use to create a fund for the Buriganga River cleanup programme and it will be collected along with the water bill on each household within Dhaka City on the basis of your opinion. However, paying for the Buriganga River cleanup programme does not provide any guarantee to free access of goods and services generated by the programme. You may need to pay for specific service/amenity at a market rate, such as, navigation, tourism and recreation and marketed product (e.g. fish and clean drinking water). Most importantly, through implementing this programme, these goods and services will be restored and developed for the use of either current generation (e.g. for you, your family members and other city dwellers) or for future generations (e.g. your grand and great children). Also, you may want such facilities to be developed not for your current or future use, but for their mere existence. As we know, Dhaka City is facing other environmental problems that you may be concerned about. This interview is about the Buriganga River only; not all other rivers around the city, or other environmental problems. Also, I am required to remind you that your household income has several important and competing uses and you need to pay the amount for the next ten years. However, I assure you that nobody is going to ask you to pay the money right now. It is only to judge your willingness and ability to pay.

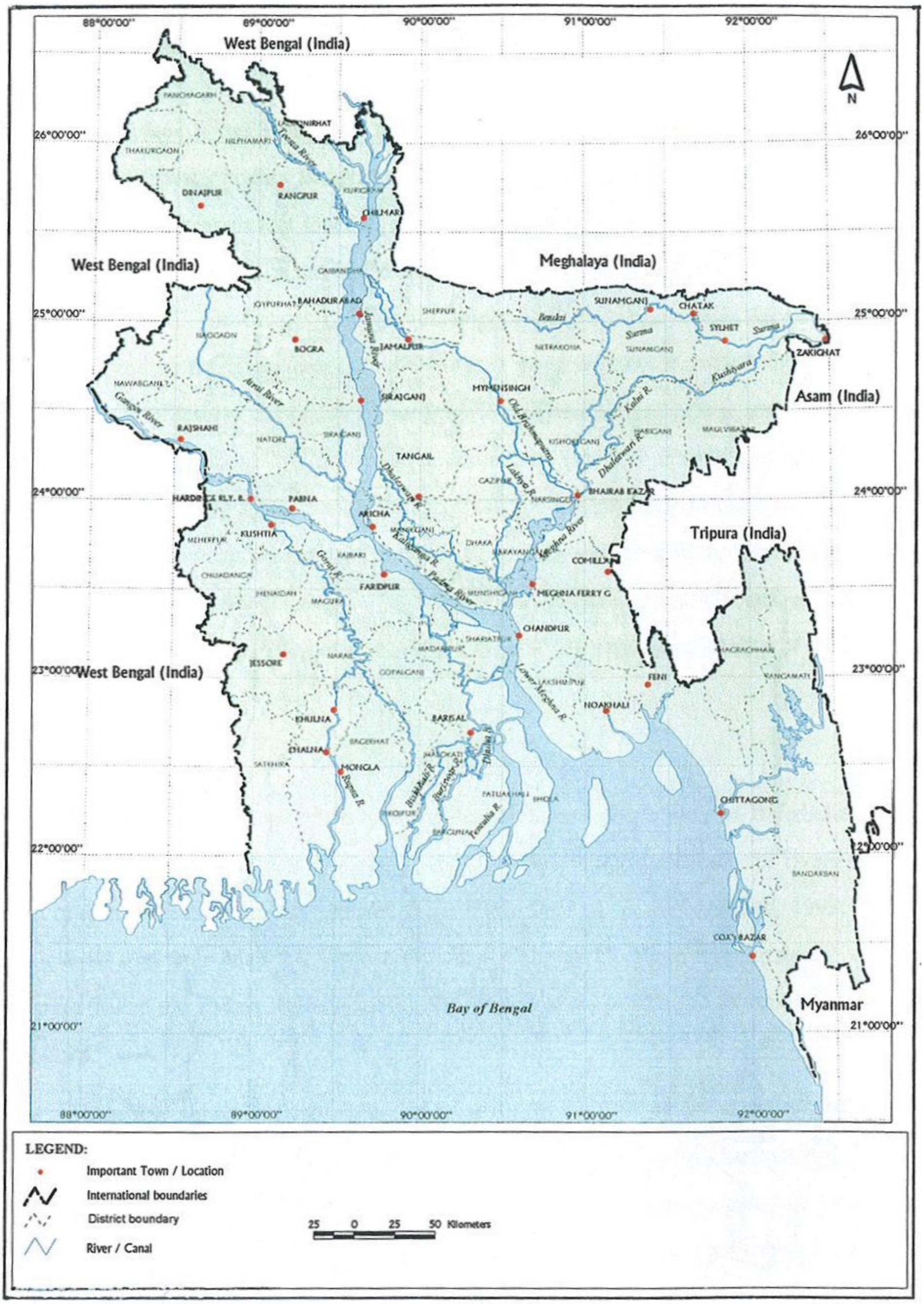
Institutional Arrangements: Given the multisectoral dimensions of the problem, a number of institutions need to be involved in the Buriganga River cleanup programme. For better coordination and smooth implementation of the programme, a taskforce will be convened with the representatives from all relevant departments. The cleanup programme will be implemented under the supervision and guidance of the taskforce. Government, private sector, community and non-government organizations may be involved with the implementation and operation of the proposed programme.

Alam, Khorshed. (2003). *Cleanup of the Buriganga River : integrating the environment into decision making*. PhD Dissertation. Perth, Murdoch University.



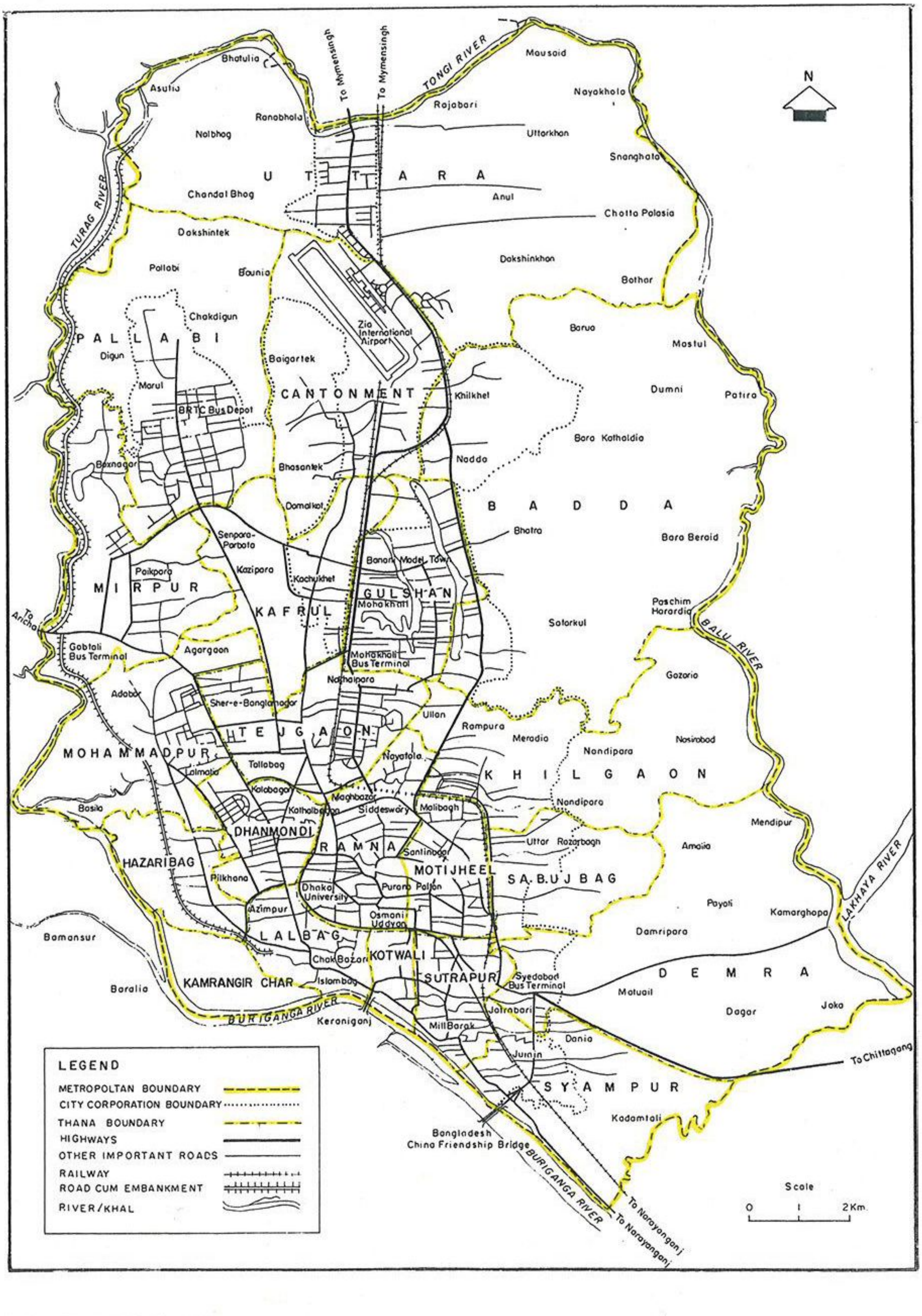
Map 2.1: *Ganges-Brahamaputra-Meghna Basin*

Source: Surface Water Modelling Centre



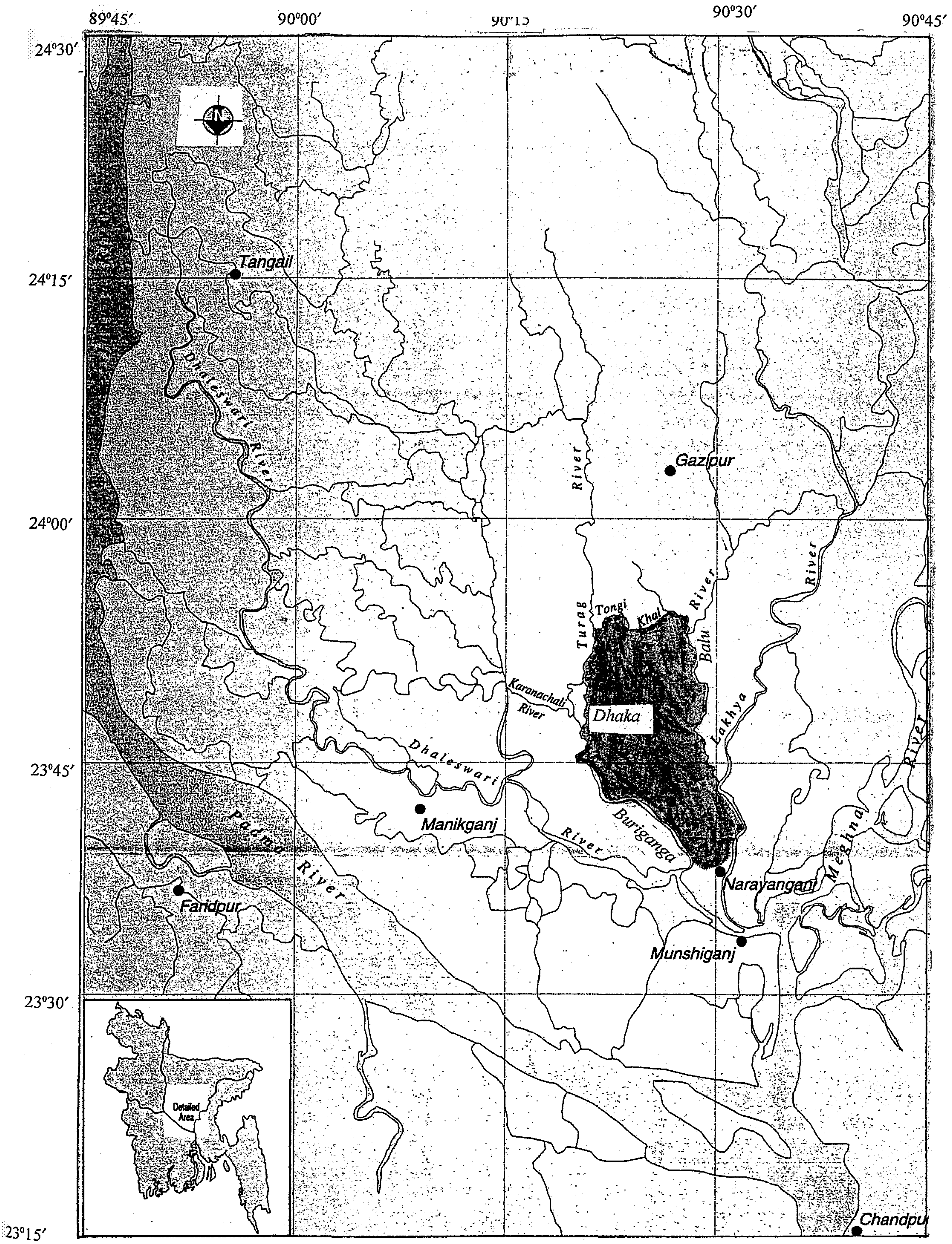
Map 2.2: River system in Bangladesh

Source: Surface Water Modelling Centre



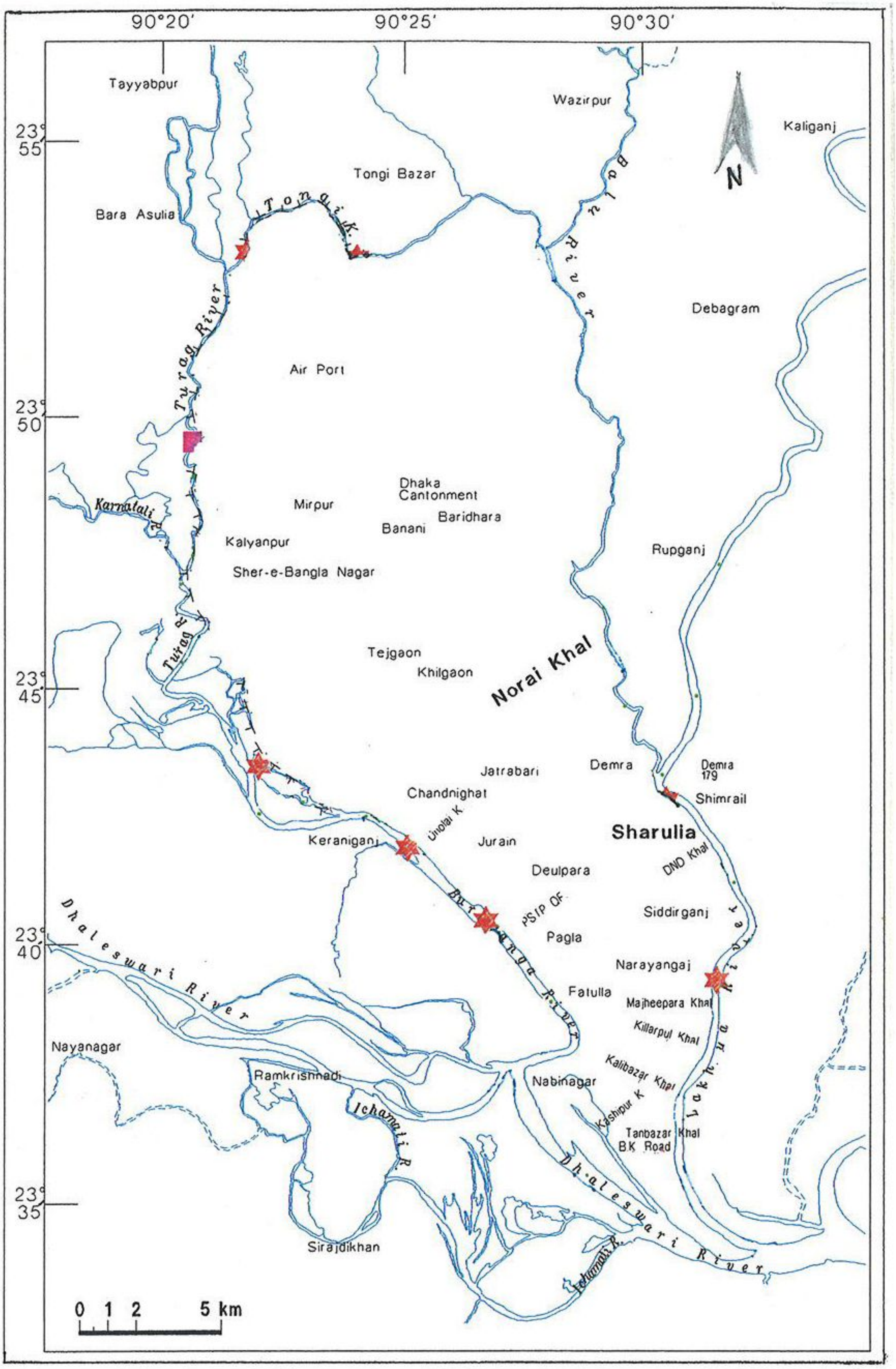
Map 2.3: *Dhaka City*

Source: Grafsman, Dhaka



Map 2.4: Dhaka City and surrounding rivers

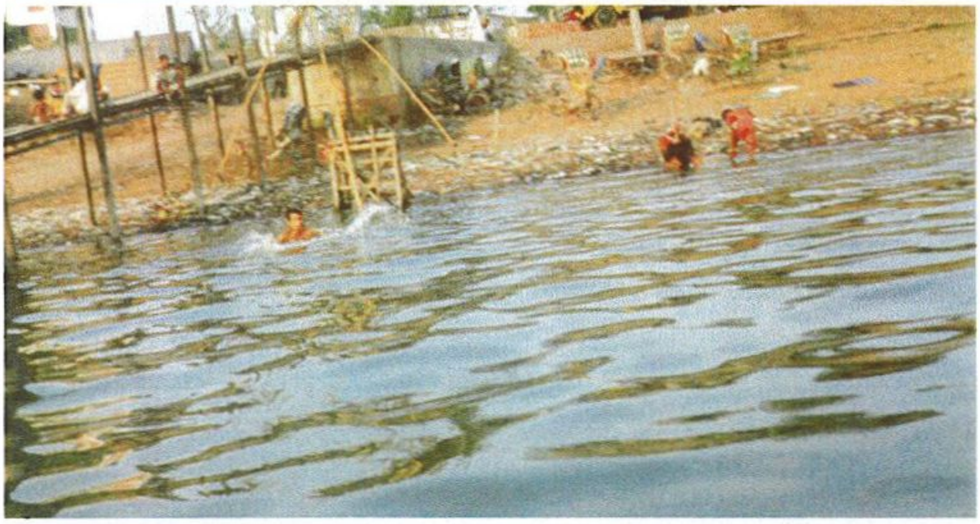
Source: Surface Water Modelling Centre



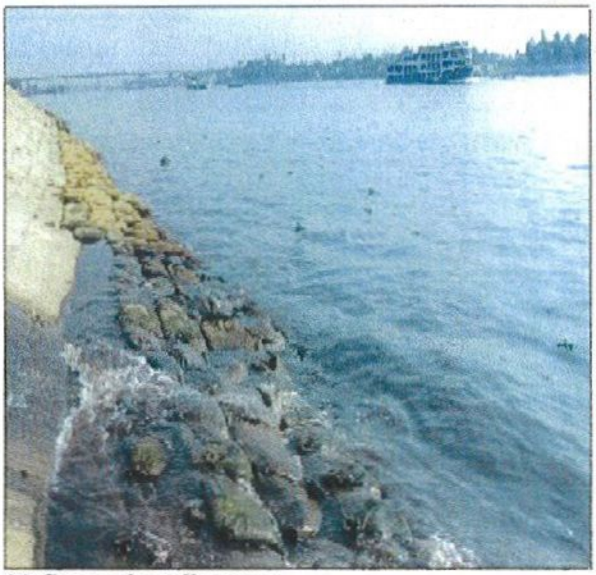
Map 2.5: *The Buriganga River system*

Source: Surface Water Modelling Centre

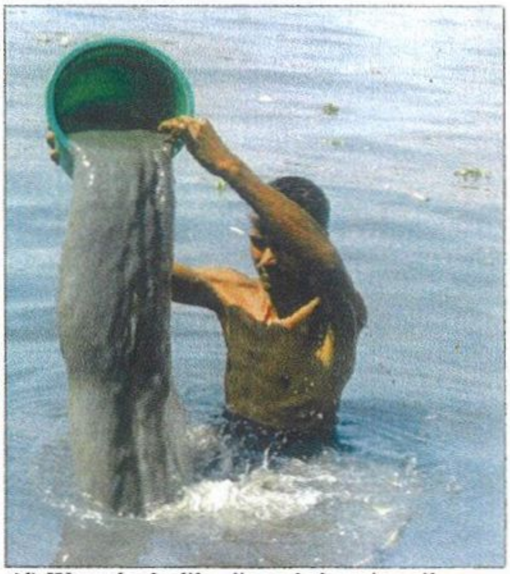
(a) Polluted water – 1



(b) Polluted water – 2



(c) Gray and smelly water
© The Daily Star



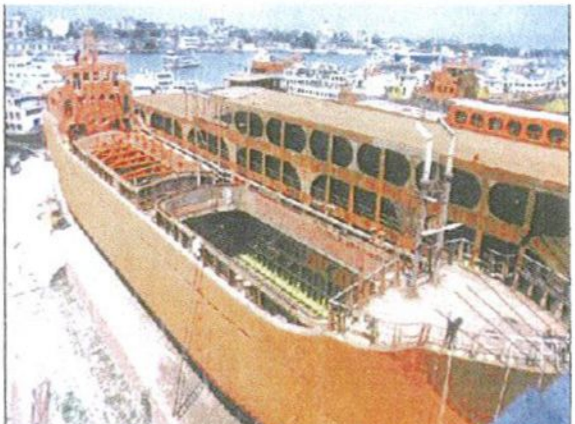
(d) Water looks like discarded engine oil
© The Daily Star

Plate 2.1: *Pollution on the Buriganga River*

(a) Fishing

(b) Washing, bathing and swimming

(c) Loading and unloading of materials

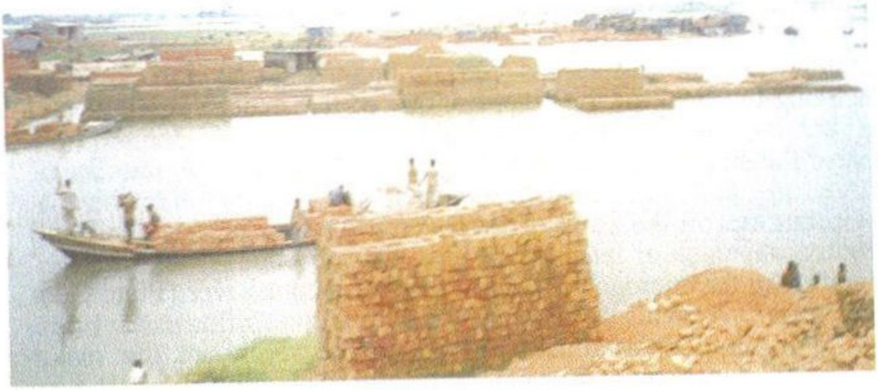


(d) Shadarghat Terminal

Plate 2.2: *Riverine activities in and around the Buriganga River*


(a) Encroachment by resident houses


(b) Encroachment by traders/ businessmen


(c) Encroachment by brick kiln


(d) Encroachment for slum/shanties mostly by influential people who rent them to poor people

Plate 2.3: *Unabated encroachment on the Buriganga River*

(a) Community dustbin spilling drains and streets at Rayer Bazar; many such drains end up in the Buriganga River

(b) Domestic sewerage and solid waste from many households like this one at Sutrapur directly go to the Buriganga River

(c) Neither sewerage nor waste management facilities exist for such slums on the Buriganga River

(d) Many DCC dumping sites close to *khals* like this one at Janapath ultimately meet the Buriganga River

Plate 2.4: *Mismanagement of solid wastes in Dhaka City*

(a) Many *khals* like this one at Sutrapur carrying both solid and wastewater, end up in the Buriganga River

(b) Hanging latrine along the Buriganga River

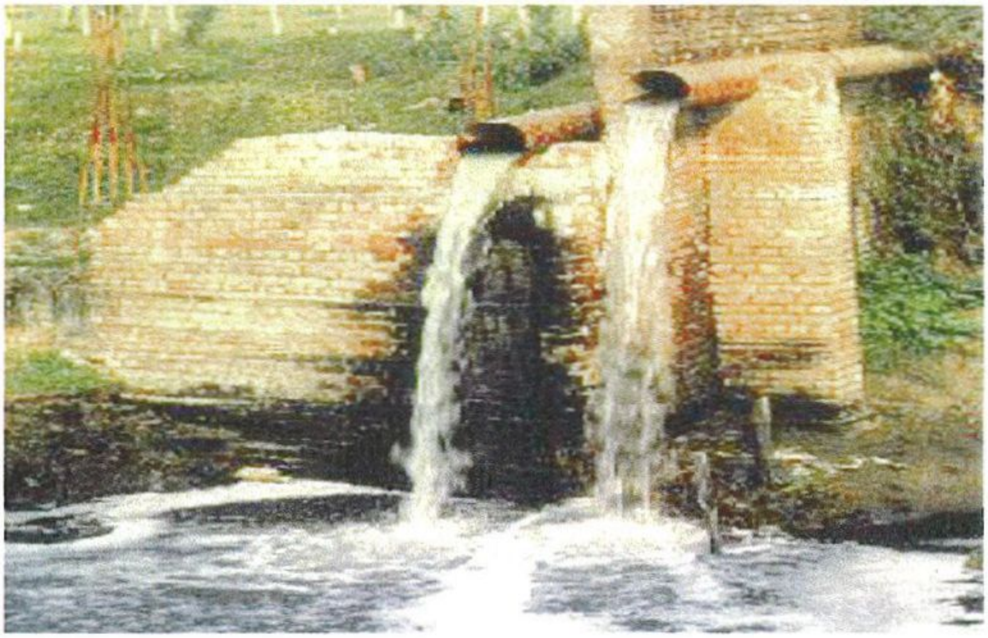
(c) Domestic sewer lines directly linked to the Buriganga River

(d) Slums/ shanties developed on the Buriganga River have neither solid waste nor sewerage disposal facilities; all end up in the river

Plate 2.5: *Mismanagement of sewerage system in Dhaka City*

(a) Many such drains carrying effluents from tanneries at Hazaribagh end up in the Buriganga River

(b) Discharges from tanneries dumped in the low-lying areas in Hazaribagh pose serious health hazards and some end up in the Buriganga River through sluice gates 7 and 8



(c) Untreated wastewater from tanneries ends up in the Buriganga River

Plate 2.6: *Industrial pollution from the Hazaribagh tanneries*

(a) Pollution by sand quarrying on the river bank

(b) Pollution by loading and unloading of building materials

(c) Pollution by shipbuilding activities on the river

(d) Pollution by sand quarrying and grinding of bricks and stones

(e) *Begunbari khal,*one of the most important *khals* in Dhaka linked with the Buriganga River, is being encroached rapidly

Plate 2.7: *Some other point sources of pollution*

Table 6.4: *Total benefit of the Buriganga River cleanup programmeover 10 years (Million Tk)*

Items	Valuation Methods	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
Components of market benefit:												
Increased navigation[a]	Market data			2.30	2.46	2.63	2.82	3.01	3.23	3.45	3.69	23.60
Increased fish production[b]	Benefit transfer					0.89	0.93	0.98	1.03	1.08	1.14	6.05
Cost saving for domestic & industrial water uses[c]	Market data		10.70	43.50	43.50	133.50	133.50	133.50	133.50	133.50	313.50	1078.70
Increased value for recreation and tourism activities[d]	Market data					2.50	2.63	2.76	2.89	3.04	3.19	17.00
Increased housing & land values[e]	Secondary data					641.88	673.97	707.67	743.06	780.21	819.22	4366.01
Improved health benefit[e]	Secondary data					18.72	19.66	20.64	21.67	22.75	23.89	127.33
Total market benefit			10.70	45.80	45.96	800.12	833.51	868.56	905.38	944.04	1164.63	5618.70
Components of non-market benefit [f] *:*												
WTC_M	CVM	175.92	186.00	196.66	207.93	219.84	232.44	245.76	259.85	274.74	290.48	2289.62
WTC_T	CVM	270.02	285.50	301.86	319.16	337.45	356.79	377.23	398.85	421.71	445.88	3514.43
WTC_T (adjusted)		211.78	223.91	236.75	250.31	264.66	279.83	295.86	312.82	330.75	349.70	2756.37
Total non-market benefit (adjusted)		387.69	409.91	433.40	458.24	484.50	512.27	541.63	572.67	605.49	640.19	5045.99
Total benefit (excluding sales revenue)		387.69	420.61	479.20	504.20	1284.63	1345.78	1410.19	1478.04	1549.52	1804.82	10664.69
Memorandum item:												
Number of Dhaka City households (Million)		1.11	1.17	1.24	1.31	1.38	1.46	1.55	1.64	1.73	1.83	

Notes: [a] It is assumed that revenue from increased navigation will increase at a 7% rate between Year 4 and Year 10.

[b] It is assumed that fish production will increase at a 5% rate between Year 6 and Year 10.

[c] Based on the DWASA's plan to develop SWTP-2 and SWTP-3 by 2005 and 2010 respectively.

[d] It is assumed that revenue from recreation & tourism activities will increase at a 5% rate between Year 6 and Year 10.

[e] It is assumed that improved health benefit and increased housing and land values will increase at a 5% rate between Year 5 and Year 10.

[f] Assumed household growth rate of 5.73%.

Source: Own estimates.

Table 6.6: Annual cost components of removal of illegal structures from the Buriganga River and construction of an access road over 10 years (Million Tk)

Items	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
Investment items:											
Manpower											
Skilled	2.00	4.00	4.00								10.00
Unskilled	3.00	3.50	3.50								10.00
Land											
Land acquisition (20.07 ha)	6.35	192.39	49.69								248.43
Duty and registration	0.30	29.51	7.45								37.27
Compensation	0.80	60.00	39.20								100.00
Construction											
Riverbank protection (7.923km)	50	50	45.12								145.12
Bridge (1)	3.00	3.00	4.00								10.00
Culverts (2)	3.00	3.00	4.00								10.00
Chutes (5)	0.10	0.20	0.10								0.40
Access road	3.00	3.00	4.00								10.00
Bench and shed (for 5.32 km)	0.50	1.00	1.00								2.50
Afforestation (5.32 km)	0.50	1.00	0.50								2.00
Awareness building	20.00	20.00	20.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	130.00
Equipment	2.00	1.00	1.00								4.00
Sub-total (investment cost)	94.55	371.61	183.56	10.00	10.00	10.00	10.00	10.00	10.00	10.00	719.71
Operation and maintenance items:											
Skilled labour	1.00	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	23.50
Unskilled labour	2.00	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	33.50
Equipment	1.00	0.25	0.25								1.50
Raw material	1.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	19.00
Repair and maintenance	5.00	5.00	10.00	10.00	11.00	12.10	13.31	14.64	16.11	17.72	114.87
Sub-total (O&M cost)	10.00	13.25	18.25	18.00	19.00	20.10	21.31	22.64	24.11	25.72	192.37
Contingency	5.23	19.24	10.09	1.40	1.45	1.51	1.57	1.63	1.71	1.79	45.60
Total cost	109.78	404.10	211.90	29.4	30.5	31.61	32.88	34.27	35.81	37.501	957.69

Notes: Contingency is estimated at 5% of total investment and operation and maintenance items.
Repair and maintenance item is increased at a 10% rate between Year 5 and Year 10.

Source: Estimates based on BWDB (2001) and expert advice from the concerned BWDB officials.

(a) House-to-house solid waste collection

(b) Sorting of wastes

(c) Decomposition of organic wastes

(d) Screening of compost

Plate 6.1: *Waste Concern's compost production at Mirpur pilot plant*

Table 6.8: *Annual cost components of decentralized solid waste management for Dhaka City over 10 years (Million Tk)*

Items	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
Investment items:											
Skilled labour	4				2						6.00
Unskilled labour	6.5				4						10.50
Land	5				4.4						9.40
Construction	10				6.51						16.51
Equipment and machinery	5				3						8.00
Sub-total (investment cost)	30.5				19.91						50.41
Operation and maintenance items:											
Wage (Unskilled labour)	27.3	30.03	33.03	36.34	39.97	43.97	48.36	53.20	58.52	64.37	435.09
Salary (Skilled labour)	1.56	1.56	1.56	1.56	3.12	3.28	3.44	3.61	3.79	3.98	27.46
Utility (water and electricity)	0.30	0.33	0.36	0.40	0.44	0.51	0.56	0.61	0.67	0.74	4.92
Maintenance	0.20	0.22	0.24	0.27	0.29	0.34	0.39	0.45	0.51	0.59	3.49
Raw materials	0.96	1.06	1.16	1.28	1.41	1.55	1.70	1.87	2.06	2.26	15.30
Sub-total (O&M cost)	30.32	33.20	36.36	39.84	45.23	49.63	54.45	59.74	65.55	71.95	486.26
Contingency	3.04	1.66	1.82	1.99	3.26	2.48	2.72	2.99	3.28	3.60	26.83
Total cost	63.86	34.86	38.18	41.83	68.40	52.11	57.17	62.73	68.83	75.54	563.51

Notes: Estimates are for 10 plants (each plant of 30 tonnes capacity) in each of the 10 zones of the whole DCC area.
After initial investment in Year 1, an expansion of the plant capacity is proposed in Year 5.
Contingency is estimated at 5% of total investment and operation and maintenance items.
Annual rate of increase for the operation and maintenance items is between 5 to 15 percent.

Source: Estimates based on Sinha and Enayetullah (2001) and expert advice from the concerned official of the WC.

Table 6.9: Annual revenue earning from compost production over 10 years

Items	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
Total solid waste management capacity (tonnes)	300	375	468.75	585.94	732.42	915.53	1144.41	1430.51	1788.14	2235.17	9975.87
No. of households covered	30000	33000	36300	39930	43923	48315.3	53146.8	58461.5	64307.7	70738.4	478122.7
Compost produced (Kg)	67500	84375	105469	131836	164795	205994	257492	321865	402331	502914	2244571
Price @ Tk 6/kg	405000	506250	632813	791016	988770	1235962	1544952	1931190	2413988	3017485	13467426
Total annual sales revenue from compost (Million Tk)	147.83	184.78	230.98	288.72	360.90	451.13	563.91	704.88	881.11	1101.38	4915.61
User fees collected from households (Million Tk)	0.45	0.50	0.54	0.60	0.66	0.72	0.80	0.88	0.96	1.06	7.17
Total revenue and user fee (Million Tk)	148.28	185.276	231.52	289.32	361.56	451.85	564.70	705.76	882.07	1102.44	4922.78
Net revenue earning (Million Tk)	84.41	150.42	193.34	247.49	293.16	399.74	507.54	643.04	813.24	1026.90	4359.28
Memo item:											
Total cost	63.86	34.86	38.18	41.83	68.40	52.11	57.17	62.73	68.83	75.54	563.51

Notes: Household coverage for solid waste collection is assumed to increase by 10% annually.
Solid waste management capacity increased 25 percent annually
User fees are charged on average at Tk 15 per household per month.

Source: Estimates based on expert advice from the concerned officials of the WC. Values of total cost is adopted from Table 6.8.

Table 6.12: *Annual cost components of wastewater treatment plant in Hazaribag over 10 years (Million Tk)*

Items	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
Investment items:											
Skilled labour	2.50	3.00	3.50	3.50	3.50						16.00
Unskilled labour	2.00	2.50	3.45	3.60	4.20						15.75
Civil construction work	20.00	118.23	15.36	67.22	28.81						249.62
Material	40.00	140.09	45.02	129.28							354.39
Electrical and mechanical equipment	2.00	2.72	17.98	4.05	9.45						36.20
Land acquisition	10.00	75.00									85.00
Consultancy	8.80	17.60	17.60	27.60	9.90						81.50
Custom duty	0.20	89.45	22.17	40.99							152.81
Others	7.35	18.37	18.37	29.39	19.60						93.07
Sub-total (investment cost)	92.85	466.97	143.45	305.62	75.46						1052.59
Operation and maintenance items:											
Skilled labour	0.21	0.85	0.85	1.23	2.97	3.27	3.59	3.95	4.35	4.78	26.07
Unskilled labour	2.00	2.10	2.21	2.32	2.43	2.55	2.68	2.81	2.95	3.10	25.16
Material and equipment	10.65	11.18	11.74	12.33	12.95	13.59	14.27	14.99	15.73	16.52	133.95
Transport	1.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	33.00
Repair, maintenance and others	7.35	18.37	18.37	29.39	19.79	20.78	21.82	22.91	24.06	25.26	208.09
Sub-total (operation and maintenance)	21.71	36.00	36.67	48.77	41.64	43.69	45.87	48.16	50.59	53.17	426.26
Contingency	5.73	25.15	9.01	17.72	5.85	2.18	2.29	2.41	2.53	2.66	75.53
Total cost	202.90	946.07	298.24	623.52	165.06	22.91	24.05	25.25	26.54	27.91	2323.35

Notes: Contingency is estimated at 5% of total investment and operation and maintenance items.

Annual rate of increase for the operation and maintenance items is between 5 to 10 percent.

Source: Estimates based on DWASA (2001b) and expert advice from the concerned DWASA officials.

Table 6.14: *Annual cost components of sewer line expansion in Dhaka City over 10 years (Million Tk)*

Items	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
Investment items:											
Skilled labour	4.00										4.00
Unskilled labour	11.00										11.00
Construction of sewer lines (12 km)	73.05										73.05
Construction of one sewerage lift station	4.00										4.00
Submersible pump and accessories	14.85										14.85
Sludge dewatering pump (2)	2.00										2.00
Total Investment cost	108.90										108.90
Operation and maintenance items:											
Skilled labour	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	9.00
Unskilled labour	3.00	3.15	3.31	3.47	3.65	3.83	4.02	4.22	4.43	4.65	37.73
Material	4.00	2.00	2.10	2.21	2.32	2.43	2.55	2.68	2.81	2.95	26.05
Chemical	2.00	1.00	1.05	1.10	1.16	1.22	1.28	1.34	1.41	1.48	13.03
Repair, rehabilitation and maintenance		3.00	5.00	5.00	7.00	10.00	10.00	10.00	12.00	12.00	74.00
Sub-total (operation and maintenance)	10.00	10.15	12.46	12.78	15.12	18.48	18.85	19.24	21.65	22.09	160.81
Contingency	5.95	0.51	0.62	0.64	0.76	0.92	0.94	0.96	1.08	1.10	13.49
Total cost	124.85	10.66	13.08	13.42	15.88	19.40	19.79	20.20	22.74	23.19	283.20

Notes: Contingency is estimated at 5% of total investment and operation and maintenance items.
Annual rate of increase for the operation and maintenance items is at 5 percent.

Source: Estimates based on DWASA (2001a) and expert advice from the concerned DWASA officials.

Table 6.16: *Annual cost components of riverbed dredging and construction of landing facilities along the Buriganga River over 10 years (Million Tk)*

Items	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
Investment items:											
Skilled labour	2.00										2.00
Unskilled labour	3.50										3.50
Land management through lease agreement	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	10.00
Construction of dyke to accommodate dredged spoil	1.00	2.50	1.00								4.50
Civil works for constructing landing facilities	3.00	4.00	3.00								10.00
Bank protection	1.00	0.50	0.50								2.00
Equipment	10.00	15.00	15.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	75.00
Dredging (capital) work	6.30	60.00	53.70								120.00
Compensation	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	15.00
Consultancy service	2.00	1.00									3.00
Coordination	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	200.00
Sub-total (investment cost)	51.30	105.50	95.70	27.50	27.50	27.50	27.50	27.50	27.50	27.50	445.00
Operation and maintenance items:											
Skilled labour	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	10.00
Unskilled labour	2.50	2.00	2.10	2.21	2.315	2.431	2.55	2.68	2.814	2.955	24.55
Maintenance dredging				1.50	1.50	1.50	1.50	1.50	1.50	1.50	10.50
Sub-total (operation and maintenance)	3.50	3.00	3.10	4.71	4.82	4.93	5.05	5.18	5.314	5.455	45.05
Contingency	2.74	5.43	4.94	1.61	1.62	1.62	1.63	1.63	1.64	1.65	24.50
Total	57.54	113.93	103.74	33.82	33.93	34.05	34.18	34.31	34.45	34.60	514.56

Notes: Contingency is estimated at 5% of total investment and operation and maintenance items.
Annual rate of increase for the operation and maintenance items is at 5 percent.

Source: Estimates based on BIWTA (2001) and expert advice from the concerned BIWTA officials.

Table 6.17: Financial cash flow of the Buriganga River cleanup programme (Million Tk)

Components	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
Investment items:											
Skilled labour	10.50	7.00	7.50	3.50	3.50						32.00
Unskilled labour	19.50	6.00	6.95	3.60	4.20						40.25
Land	17.35	268.39	50.69	1.00	1.00	1.00	1.00	1.00	1.00	1.00	343.43
Construction	167.95	245.43	131.78	67.22	28.81						641.19
Material and equipment	90.85	178.81	99.00	158.33	34.45	25.00	25.00	25.00	25.00	25.00	686.44
Consultancy	30.80	38.60	37.60	37.60	19.90	10.00	10.00	10.00	10.00	10.00	214.50
Tax and duty	0.50	118.96	29.62	40.99							190.07
Compensation	2.30	61.50	40.70	1.50	1.50	1.50	1.50	1.50	1.50	1.50	115.00
Others	7.85	19.37	18.87	29.39	19.60						95.07
Sub-total (investment cost)	347.60	944.07	422.70	343.12	112.96	37.50	37.50	37.50	37.50	37.50	2357.95
Operation and maintenance items:											
Skilled labour	3.21	5.35	5.35	5.73	7.47	7.77	8.09	8.45	8.85	9.28	69.57
Unskilled labour	9.50	10.75	11.11	11.49	11.89	12.31	12.75	13.22	13.70	14.21	120.94
Material and equipment	19.65	17.18	17.89	17.64	18.42	19.24	20.10	21.01	21.96	22.95	196.03
Repair and maintenance	12.35	26.37	33.37	45.89	39.29	44.38	46.63	49.05	53.66	56.47	407.46
Transport	1.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	33.00
Sub-total (O&M cost)	46.21	63.15	71.22	84.25	80.57	87.20	91.08	95.23	101.67	106.42	827.00
Contingency	19.70	50.37	24.70	21.37	9.68	6.23	6.43	6.63	6.96	7.20	159.24
Total cost	413.51	1057.59	518.63	448.74	203.21	130.92	135.00	139.36	146.12	151.12	3344.20
Total benefit (excluding revenue)	387.69	420.61	479.20	504.20	1284.63	1345.78	1410.19	1478.04	1549.52	1804.82	10664.69
Sales revenue											
Solid waste	84.41	150.42	193.34	247.49	293.16	399.74	507.54	643.04	813.24	1026.90	4359.28
Effluent treatment					7.40	7.40	7.40	7.40	7.40	7.40	44.40
Total benefit (including revenue)	472.11	571.03	672.55	751.69	1585.19	1752.91	1925.13	2128.48	2370.16	2839.12	15068.36
Net benefit	58.60	-486.56	153.92	302.95	1381.98	1621.99	1790.12	1989.12	2224.04	2688.00	11724.17
NPV @ 10.11% = Tk 5,530.78 million											
IRR = 129%											
BCR = 3.31											
Memorandum items:											
Discount factor @10.11%	1	0.9082	0.8248	0.7491	0.6803	0.6178	0.5611	0.5096	0.4628	0.4203	
Discounted benefits @ 10.11%	472.1	518.6	554.7	563.1	1,078.4	1,083.0	1,080.2	1,084.6	1,096.9	1,193.3	8,724.9
Discounted costs @ 10.11%	413.51	960.48	427.76	336.14	138.24	80.89	75.75	71.01	67.62	63.52	2,634.9

Source: Own calculation based on Table 6.4, Table 6.6, Table 6.9, Table 6.12, Table 6.14 and Table 6.16.

Table 6.18: *Economic cash flow for the Buriganga River cleanup programme (Million Tk)*

Items	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
Investment items:											
Skilled labour	8.61	5.74	6.15	2.87	2.87						26.24
Unskilled labour	14.24	4.38	5.07	2.63	3.07						29.38
Tradables	171.40	276.76	151.74	139.18	42.87	13.50	13.50	13.50	13.50	13.50	849.45
Non-tradables	101.97	363.34	138.86	113.89	46.02	17.22	17.22	17.22	17.22	17.22	850.18
Total (investment)	296.21	650.22	301.81	258.57	94.83	30.72	30.72	30.72	30.72	30.72	1755.25
O&M items:											
Skilled labour	2.63	4.39	4.39	4.70	6.13	6.37	6.64	6.93	7.26	7.61	57.04
Unskilled labour	6.94	7.85	8.11	8.39	8.68	8.99	9.31	9.65	10.00	10.37	88.29
Tradables	12.83	14.02	15.67	17.78	17.02	18.38	19.25	20.17	21.52	22.56	179.20
Non-tradables	15.07	25.18	29.98	38.12	34.02	37.60	39.33	41.18	44.48	46.62	351.60
Total (O&M)	37.47	51.45	58.15	69.00	65.85	71.34	74.52	77.93	83.26	87.17	676.13
Contingency:											
Tradables	3.55	9.07	4.45	3.85	1.74	1.12	1.16	1.19	1.25	1.30	28.66
Non-tradables	12.92	33.04	16.20	14.02	6.35	4.08	4.21	4.35	4.56	4.72	104.46
Total Contingency	16.47	42.11	20.65	17.87	8.09	5.20	5.37	5.54	5.81	6.02	133.13
Grand total (cost)	350.15	743.77	380.61	345.43	168.77	107.26	110.61	114.20	119.79	123.90	2564.50
Total benefit	472.11	571.03	672.55	751.69	1585.19	1752.9	1925.1	2128.48	2370.16	2839.12	15068.36
Net benefit	121.96	-172.74	291.93	406.26	1416.42	1645.7	1814.5	2014.28	2250.37	2715.21	12503.86
Memorandum items:											
Discount factor	1.00	0.9082	0.8248	0.7491	0.6803	0.6178	0.5611	0.5096	0.4628	0.4203	
Discounted benefit	472.11	518.60	554.71	563.07	1078.39	1083.00	1080.19	1084.63	1096.89	1193.28	8724.86
Discounted cost	350.15	675.48	313.93	258.75	114.81	66.27	62.07	58.19	55.44	52.08	2007.16
Discounted net benefit	121.96	-156.88	240.78	304.31	963.57	1016.73	1018.12	1026.44	1041.45	1141.20	6717.69
NPV @ 10.11% = Tk 6100.89 Million											
IRR @ 10.11% discount rate = 822											
BCR = 4.35											

Source: Own calculation based on Table 6.6, Table 6.9, Table 6.12, Table 6.14, Table 6.16 and Table 6.17.

Table 6.20: *Sensitivity analysis for the Buriganga River cleanup programme (Million Tk)*

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
Scenario 1											
Total benefit	472.11	571.03	672.55	751.69	1585.19	1752.91	1925.13	2128.48	2370.16	2839.12	15068.36
Total cost	385.17	818.149	418.68	379.97	185.65	117.99	121.68	125.62	131.77	136.29	2820.95
Net benefit	86.94	-247.12	253.87	371.72	1399.54	1634.93	1803.45	2002.86	2238.39	2702.82	12247.41
NPV @ 10.11% = Tk 5918.61											
Scenario 2											
Total benefit	377.69	456.83	538.04	601.35	1268.15	1402.33	1540.10	1702.78	1896.13	2271.29	12054.69
Total cost	350.15	743.77	380.61	345.43	168.77	107.26	110.61	114.20	119.79	123.90	2564.50
Net benefit	27.53	-286.95	157.42	255.92	1099.38	1295.07	1429.49	1588.59	1776.34	2147.39	9490.19
NPV @ 10.11% = Tk 4,516.14 million											
Scenario 3											
NPV @ 15% = Tk 4,466.81											
Scenario 4											
NPV @ 7% = Tk 7,524.44											
Scenario 5											
Total benefit		10.70	45.80	45.96	800.12	833.51	868.56	905.38	944.04	1164.63	5618.70
Net benefit	-350.15	-733.07	-334.81	-299.47	631.35	726.25	757.95	791.18	824.25	1040.73	3054.20
NPV @ 10.11% = Tk 916.48 million											
Scenario 6											
Total benefit	175.92	196.70	242.46	253.89	1019.97	1065.95	1114.33	1165.23	1218.78	1455.12	7908.32
Net benefit	-174.24	-547.07	-138.16	-91.54	851.20	958.69	1003.71	1051.03	1098.98	1331.21	5343.82
NPV @ 10.11% = Tk 2256.50 million											
Memo items:											
Total benefit	472.11	571.03	672.55	751.69	1585.19	1752.91	1925.13	2128.48	2370.16	2839.12	15068.36
Total cost	350.15	743.77	380.61	345.43	168.77	107.26	110.61	114.20	119.79	123.90	2564.50
Net benefit	121.96	-172.74	291.93	406.26	1416.42	1645.65	1814.51	2014.28	2250.37	2715.21	12503.86

Source: Own calculation based on Table 6.4 and Table 6.18.