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Sustainability and River Restoration

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Abstract
One of the major problems causing the accelerating widespread destruction and degradation of the natural environment is the undervaluing of the protection and restoration of environmental resources that takes place in the decision making process. This paper argues that non-market values need to be incorporated in the benefit estimation process to make the concept of sustainability operational under the current market mechanism. It uses the case study of the Buriganga, a vulnerable river in Bangladesh, to demonstrate that a failure to account for such benefits could lead to gross underestimation of the desirability of providing public funding for its restoration.

Keywords: benefit estimation, Buriganga River**,** contingent valuation and total economic value.

1.0 Introduction

The concept of sustainability[1] has gained currency since the publication of the report of the World Commission on Environment and Development, commonly known as the Brundtland Report, in 1987 and the Earth Summit (United Nations Conference on Environment and Development) in Rio de Janeiro in 1992. The acceptance of this concept is recognized in subsequent guidance of policies for many governments and international agencies. However, there is still a debate about the definition, measurement indicators and operational mechanism of this concept (Hediger, 1997; Alam, 2000). Many consider it as a contested concept with a wide range of meanings trying to satisfy different situations at the same time (Giddings *et al.*, 2002). Nevertheless, there is a growing broad acceptance for the concept at all levels of governance in developed and developing countries as well as in transitional economies. Despite its different interpretation by various quarters to satisfy different situations and particularly different levels of market development, the most recognized and widely cited interpretation of sustainable development is that given by the Brundtland Commission:

> development that meets the needs of the present without compromising the ability of future generations to meet their own needs *(*WCED, 1987: 87).

This definition implies that there should be an obligation on the part of the current generation to pass on world's natural resources to future generations in no worse condition than received by them. Stoneham *et al.* (2003) define sustainable development as "concerns about the living standards of

[1] Although many argue that the terms 'sustainability' and 'sustainable development' do not mean the same (Hediger, 1997; Mitra, 2003), in this paper they are used interchangeably (as for example in GWA, 2003).

future generations and their right to inherit a natural resource base of undiminished value" (p: 195). Imberger (2003) talks about human actions being sustainable provided that the rate of change brought about by these actions is slower than the rate at which the natural system can respond without losing its functionality. It is clear that at the core of the concept of sustainability are concerns for future generations and the state of natural resources. This is generally based on the understanding that both over-use and mis-use of natural resources by the current generation have significant and often irreversible consequences for future generations.

One approach of achieving the objectives of the sustainability is to maintain a constant stock of natural capital through time[2] (Alam, 1999; Stoneham *et al.,* 2003). Since as a rule this objective cannot be achieved automatically, trade-offs exist. The pertinent question hence is: how much should be sacrificed for the sake of future generations? In some cases it may appear that it is possible to substitute natural capital for other forms of capital and leave an equivalent base for future generations. Nevertheless, there are concerns that major depletions of natural capital could create a situation of resource scarcity where future generations might be deprived of a minimum physical stock of natural resources and therefore suffer declining living standards. On the other hand, restrictions on the use of the stock of current resources particularly in developing countries may disadvantage current generation and favour future generations.

From the policy decision-making perspective, one approach to resolving this conflict is to allow markets to signal the true scarcity value[3] of resources. However, problems stem from the fact that many environmental resources[4] (e.g. clean air and healthy waterways) do not pass through markets and are therefore not priced in the traditional sense. In these cases, if at all, the market price is a poor or distorted measure of scarcity value or opportunity cost of these resources. Consequently, the existing decision making process cannot take into account the scarcity values of many natural resources, particularly non-renewable. Against a backdrop that the market economy is the dominant economic paradigm, there is a role for the economic valuation of environmental goods and services. There is potential for natural resource management to be made more 'sustainable' by incorporating the social or opportunity costs of resource use into the decision-making process through proper economic valuation.

One of the major problems causing the accelerating widespread destruction and degradation of the natural environment in developing countries such as Bangladesh is the undervaluing of the protection and restoration of environmental resources. These countries have limited resources to meet a number of imperatives including economic growth, poverty alleviation and environmental protection. Such objectives compete for resources and often conflict with one another. A focus on market benefits[5], and the exclusion of non-market benefits in many decision-making processes mean that environmental protection measures are left with very limited resources.

An improved environmental protection and more sustainable resource use can only be achieved if non-market benefits are incorporated into the decision-making process. This can potentially allow to avoid

[2] WCED (1987) used the term 'non-declining capital stock'.

[3] The existence of scarcity of any of the resources implies that choices have to be made about how resources are to be allocated within an economy.

[4] The terms 'environmental resources', 'environmental goods or services' and 'public goods or services' are used interchangeably in this paper as they reflect the common characteristics of non-rivalry and non-excludability.

[5] Market benefits are benefits which have established markets or are exchanged through markets, and thus have a price tag; while non-market benefits are benefits which do not have an established market and thus do not bear any price.

developments where positive financial outcomes are swamped by non-market costs, particularly when the latter occur over the longer term. Estimation of non-market benefits from environmental protection may also help to counter arguments that environmental degradation is an unavoidable cost of economic development in poor economies such as Bangladesh. As Pearce *et al.* (2002) show, people in developing countries may hold significant values for environmental goods and protection and this should be reflected in any development processes.

In many cases, if an intervention is not undertaken now, future generations would find the restoration of decaying resources costly and even impossible to recover. A framework that provides for benefit estimation from the restoration of decaying/degrading resources therefore could prove to be a useful tool to counteract to this happening.

This paper analyses a particular case study, namely the Buriganga River in Bangladesh as an example of a way to assess and incorporate non-market benefits in policy decision making. It argues that if these considerations are taken into account, a better environmental protection and an improved river management can be achieved which overall will provide for a more sustainable development. The reminder of the paper is set out as follows. In the next section, a review of the total economic valuation approach is presented in the context of a river restoration program, with a description of the study area and data collection procedures. Section three reports how the consideration of non-market benefits could assist informed decision making, particularly in the context of a developing country. Final conclusions are presented in section four.

2.0 Material and Method

Although based on a very specifically shaped methodology and information, the thrust of the sections to follow goes beyond the case study chosen for this paper. The devised approach and method are particularly appropriate to countries where the market mechanisms (including the labour market) are underdeveloped but they can also be applied to environmental situations in the more advanced countries. They provide an operational framework which potentially can tap a wide range of unaccounted resources within society. The case study and the method are presented below.

2.1 Case Study: The Buriganga River

Old Dhaka 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. This river has enormous significance to the residents of Dhaka City, the capital of Bangladesh. Not only does it surround two sides of the city, it provides important services to the residents, including water supply, navigation, recreation, sanitation and flood control.

This vital river however has become extremely polluted and is close to biological death for several reasons. The tremendous increase in population over the last three decades has created enormous environmental problems, including among others the disposal of solid waste, sewage and drainage problems. Furthermore, there are several industrial locations within Dhaka city which pose challenges for the environmentally sound management of industrial discharges. The water quality of the Buriganga River has been seriously affected by the dumping of municipal waste and toxic industrial discharges from industries on its banks, especially from the tanneries of the Hazaribagh. The problems are 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 problems facing the Buriganga River are not unique, but are representative of the other vulnerable rivers in Bangladesh. The lack of water quality data and other information for many rivers in Bangladesh makes it difficult to establish which rivers are threatened. The Department of Environment (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 many 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. Alam (2004) uses content analysis of newspaper reporting to pinpoint vulnerable rivers in different parts of Bangladesh. The list includes the Baleshwar, Balu, Betna, Buriganga, Dakatia, Dhaleswari, Ghagot, Gorai, Ichhamoti, Kabodakha, Karatowa, Karnaphuli, Kumar, Mogra, Old Brahamaputra, Rupsa, Shitalakhya, Surma, Tongi and Turag. He asserts that about one third of the country's rivers, particularly those passing through big cities, are vulnerable and affected by major environmental damages. The Buriganga River stands out among these rivers with having the worst problems in terms of pollution and encroachment.

The Buriganga River thus represents a good case study for the emerging problems and threats rivers in Bangladesh are now facing. The problems of environmental degradation are widely observed and recognised, but the key issue is to do something for the ecological restoration of the reverine environment. Although significant, the potential costs of a restoration and protection program can be justified by the resulting benefits. To address this question, a hypothetical restoration program has been designed to help assess the people's values, attitudes and potential benefits from a cleaner river.

2.2 Analytical Framework

Estimating the benefits of a restoration program is complicated because the resource in question is not a marketed good as a whole, although particular components can be marketed. The total benefit of the restoration program is estimated using complimentary non-market and market valuation techniques, within a total economic value framework. Non-market benefits are estimated with the contingent valuation technique, and market data are used for assessing market benefits. These concepts and techniques are described below.

2.2.1 Total Economic Value

The total benefits are estimated using the concept of 'total economic value' (TEV). 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 derived from a good or service for which no payments are made (e.g. clean air or water). 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). These values constitute a broadly accepted taxonomy which, when aggregated, is called the 'total economic value' (Munasinghe, 1993 and Young, 2001). The total economic value of environmental goods and services consists of two types of values – use values and non-use values (Munasinghe, 1993; Barbier, 1994; Pearce and Moran, 1994 and Young, 2001). Use values are related to the direct or indirect use of a resource, while non-use values, also called passive use values, are not related to its use, and include option value, i.e. the value of retaining the right to use at some point in the future, existence value, i.e. the value of simply knowing that a resource exists, and bequest value, i.e. the value of a resource's preservation for the use of future generations (Lindsey *et al.*, 1995; Goodman *et al.*, 1998).

2.2.2 Difficulties in Measuring Total Economic Value

Although defining values for environmental protection measures is not a difficult task conceptually, the derivation as well as measurement of components are in reality a more daunting task. While use values can be readily measured by market prices and tend to be well accounted for in decision-making processes, non-use values are problematic because they are not traded and therefore cannot be valued by market prices.

The measurement/quantification issue is further complicated, particularly in the context of developing countries such as Bangladesh, where a larger share of the components of TEV do not have established markets. For example, although information about the monetary value of clean water for consumptive uses such as irrigation, fishing, navigation or domestic use, may be 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. Therefore, a cleaner river as a whole is a public good in nature and it is possible to establish private property rights for only a limited number of its components. Also, in some cases reliable data for quantification of benefits are absent. For example, data are absent either for existing or any projected fish catch in the Buriganga River.

The absence of markets for the goods or services related to a clean river does not mean that they are not economically valuable or improvements do not bear any value. What it does mean is that there are no observable market prices for them that can be related to levels of service use in order to estimate the demand function required for welfare measurement[6]. 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 difficulties related to missing markets for environmental goods make the benefit estimation process a challenging task. In order to overcome this complexity, the TEV is separated into market and non-market components. Estimates of market benefits are done using data/information available in the market assuming that market prices closely reflect social values (although market prices of environmental functions may not always be a reasonable approximation of their social value due to perverse subsidies and taxes). For non-market benefits, specialized valuation techniques such as the contingent valuation method (CVM) can be used.

In the case of the Buriganga River restoration program, benefits are expected to accrue to the households both directly (mainly use values) and indirectly (mainly non-use values). Direct benefits are expected to flow through increased provision of goods and services (e.g. an increase 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, tourism and recreation). Indirect benefits are expected to be generated through the existence of a healthier environment both for current

[6] Welfare economics is considered to provide the best suited neoclassical economic model for environmental goods and hence the production function.

and future generations. The lack of market data means that most components of TEV need to be assessed through the use of a non-market valuation technique.

When the framework of TEV is applied in the case of the Buriganga River restoration program, only some direct use benefits could be estimated using market data. Due to either non-existence or malfunctioning of markets, all other components of TEV were measured using the CVM to elicit residents' willingness to contribute (WTC) for the restoration program. Table 1 presents the appropriate method used to estimate each component of the Buriganga River restoration program.

2.2.3 Contingent Valuation Method

The contingent valuation method (CVM) invokes a framework of a contingent (i.e. hypothetical or constructed) market used to elicit valuations from individuals for both market and non-market goods and services. The CVM is widely applied for estimating non-use values or components of TEV (Mitchell and Carson, 1989). 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 most practiced method for measuring non-use values (Freeman, 1993; Carson *et al.*, 1995; 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. This is not a rare occurrence and over the years, the CVM has been used to estimate both use and non-use values, i.e. all components together. In other words, a combination of components of the TEV can be measured through the CVM (Carson *et al.*, 1992; Diamond and Hausman, 1993; Hoevenagel, 1994; Bateman and Langford, 1997; Berrens *et al.*, 2000, Russell, 2001 and Tyrväinen, 2001). 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). In the study on river restoration values in Dhaka City, the CVM was chosen to assess a package of use, indirect use and non-use values held by the relevant population. The survey instrument, particularly the contingent valuation (CV) scenario, was designed with these multiple functions in mind.

With the CVM, a hypothetical scenario is specified, and 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 in the supply of an existing amenity. 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).

Although the CVM is appreciated for its unique ability to measure non-use values as well as TEV, there is a large body of literature criticizing 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 (see, for example, Cummings and Harrison, 1994) is that it is based on a hypothetical market which in reality is non-existent. The critics (e.g. Diamond and Hausman, 1994, Cummings *et* *al.*, 1995) argue that the answers obtained in hypothetical situations are subject to a variety of potential biases which make resulting value estimates suspect. However, both theoretical and empirical developments with CVM 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 them (Mitchell and Carson, 1989; Hanemann, 1994). As Angelsen *et al.* (1994: 49) state, "[t]he conclusion is not that the CV 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".

Table 1: *Taxonomy of the total economic value of the Buriganga restoration program*

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	CVM
• Tourism and recreation	Market data
• Educational, scientific and cultural purposes	CVM
• Improved health benefit	Market data
• Bathing, washing and boating	CVM
Indirect Use Values	
• Riverbank erosion prevention	CVM
• Flood control	CVM
• Reduced damage to downstream irrigation system	CVM
• Biodiversity	CVM
• Ecological function (e.g. watershed protection)	CVM
• Pollution assimilative capacity	CVM
Non-use Values	
Option Values	
• Biodiversity	CVM
• Future use (e.g. recreation option)	CVM
• Potential gene pool	CVM
Existence Values	
• Satisfaction from knowledge of existence of clean water	CVM
• Aesthetic benefits	CVM
• Biodiversity	CVM
• Spiritual and religious	CVM
Bequest Values	
• Value arising from the knowledge that the river remains healthy and viable and will persist for future generation	CVM
• Biodiversity	CVM

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 the advantages and disadvantages of the CVM, Russell (2001) states that "[t]he survival and growth of CV 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 provide valid estimates. Seen in this light, the CVM can make an important contribution to measuring benefits in addressing environmental problems and aiding policy making both in developed and developing countries.

The theory and standard application of CVM however reveal that the conventional approach to payment vehicles used to estimate people's WTP is targeted towards developed market economies. They are much less suited to capture the issue of non-monetization of many economies. This means that the respondents' preference evaluation through asking their willingness to pay might not capture full value elicitation in the context of developing countries such as Bangladesh. To overcome this drawback, an extension of the CVM is proposed (Alam, 2004). It requires respondents to be asked about their willingness to contribute time, along with the conventional approach of asking the WTP question.

A CV scenario was framed for the case study which captures the non-market benefits of the Buriganga River Restoration Program (BRRP) which was hypothetically proposed over a 10-year period. The survey design uses a payment card elicitation format, and an increase in water bill as a payment vehicle. The valuation question was framed to elicit non-market benefits for a period of ten years. The study area was restricted to Dhaka City[7]. Using a stratified random sampling technique[8], 400 households (from a total of 643,016) in Dhaka City were interviewed in 2001. The survey questionnaire was refined using inputs from focus group discussions, and pre-tested before fielded for implementation.

2.4 Methods for Estimating Market Benefits

The value of some market benefits were estimated in this study from market data (see Table 1) as well as information from primary and secondary sources, such as personal communication through interviews with relevant government departments in Bangladesh, using published or available documents, expert opinion and transferring values from other studies. Market data are derived either from observed market prices or imputed from related markets for the market benefit components of the

[7] Although considerable differences exist among different departments in Bangladesh about the boundary of the city, the demarcation of the Dhaka City Corporation (DCC) is used in this study. The DCC area is 360 sq km.

[8] The study area was stratified into two constituents: 'Buriganga River area' (BRA), i.e. adjacent to the river, and 'outside Buriganga area' (OBA). Distance of locality from the river was used as the basis of this demarcation.

BRRP. Based on the classification of the TEV above (see Table 1), this approach can only be used to value goods and services that have established markets. Market prices of goods and services, where necessary, were corrected for distorting market imperfections such as taxes, subsidies and unemployment. The focus in this analysis is not so much on the absolute numbers, rather on the expected changes resulting from the BRRP.

3.0 Research Findings

The components of the TEV, described earlier, suggest that both survey and market data were required for an estimation of the TEV of the BRRP; non-market benefits were measured through a CVM survey, and market benefits were estimated using market and secondary data. The survey was designed to elicit non-market benefits of the total value of the BRRP independently of the market benefits. The research findings are presented below.

3.1 Estimates of Non-market Benefits

Non-market benefits were estimated in a two-part framework designed to elicit respondents' preferences – the two parts being: (1) willingness to pay referred to as willingness to contribute money (WTC_M) and (2) willingness to contribute time (WTC_T). These two estimates together constitute the total non-market benefit of the BRRP, which is referred to as respondents' willingness to contribute (WTC). The non-monetary contribution as expressed in time was converted into monetary values[9], so that WTC could be expressed as a single term. The survey found that in 2001 (at the time of the survey) the median monthly WTC_M was Tk 51.91[10] and the median monthly WTC_T was Tk 62.04. In order to provide the total non-market benefit estimation, these WTC values were then extrapolated for the whole population. The total annual value of non-market benefits is shown in Table 2.

Table 2: *Estimate of yearly non-market benefits*

Category	Amount in Tk
Total number of households in Dhaka City	1,107,474
Households' average WTC_M per month (Proportion of household WTC_M: 25.50%)	51.91
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: CV survey (Alam, 2004) 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. In Table 2, a simple aggregate estimate of the total annual WTC across the whole of Dhaka City was derived by multiplying the survey's median monthly WTC_M (Tk 51.91) by the number of households in Dhaka City. The result of this product was approximately Tk 176 million per year. The WTC_T value was also extrapolated for the total population of Dhaka City, summing to about Tk 270 million per annum. The total WTC value for the residents of Dhaka City was estimated at about Tk 446 million

[9] Respondents' preferences for time were sought for six categories of work ranging from physical labour to consultancy service. This contribution together with data on current market rates of wage and salary in the study area was used to estimate the WTC_T in monetary terms.

[10] Taka (Tk) is the Bangladesh currency. US$ 1.00 = Tk 57.00 (as in June 2001).

(Table 2) by adding these two values. 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 just 40 percent of this total amount. The total value of non-market benefits expected to be generated by the BRRP is estimated as Tk 446 million. Alternatively, this figure can be interpreted as estimates of the gross benefits arising from the BRRP for which market values do not exist.

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 considering that about 55 percent of the residents in Dhaka City live below the poverty line[11]. Such information about residents' willingness to contribute could be extremely valuable for decision-making bodies. The application of CVM 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 river restoration program.

3.2 Estimates of Market Benefits[12]

Market benefits are direct benefits where information about peoples' use can be analysed through market transactions. They are estimated in this section using mostly market data. The relevant 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.

3.2.1 Increased Housing and Land Value

The improved ecological health of the river would make the land and houses in the surrounding areas more attractive. This would 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, the expected increased value of the land and rental properties is estimated here using secondary data.

Table 3: *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

[11] 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 2,122 kilocalorie (PC, 1998).

[12] This section draws from preliminary findings of this study in Alam and Marinova (2003).

Total housing & land values	Tk 46.76 million	Tk 53.49 million
Human health impact No. of persons sick Cost of treatment per person	Tk 1.17 million 3,197 Tk 364.78	Tk 1.56 million 3,749 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: Estimates based on Haque *et al.* (1997).

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 odour and deteriorated living conditions caused by tannery industries[13]. The benefit transfer approach (i.e. assuming the benefit similar to that of a comparable situation) allows to estimate the lost value of land price and rent using the same information adjusted for the consumer price index (CPI) from 1997 to 2001 and the increase in resident population. The estimated value for year 2001 is Tk 53.49 million per month or Tk 641.88 million per year (see Table 3). This benefit is assumed to be achieved in Year 5 of the BRRP. 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 4 summarizing the total benefits of the BRRP for the 10 year period.

3.2.2 Improved Health Benefits

Water-born or water-bred diseases account for a major share of health problems affecting the population along the banks of the Buriganga River. These diseases 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 banks 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 restoration program is expected to improve the overall health of the people, particularly those living in close proximity to the river in the 'Buriganga River Area (BRA)'. The expected health benefits are likely to occur with the BRRP 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 medicine, consult a doctor or lose a day's wage. Accordingly, health benefits due to the restoration program have two dimensions: avoided

[13] Among a host of sources, pollution by tannery industries is identified as the most serious environmental hazard to the health of the Buriganga River. Within a small area of 25 hectares in the Hazaribagh in the heart of Dhaka City, about 149 tanneries generate 16,000 cubic metres of highly toxic wastes which flow every day first to low-lying areas and then to the Buriganga River (Alam, 2004).

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 BRRP 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 3). This estimate is adopted for the health benefits of the restoration program taking into consideration the increased population and inflation up to 2001 (Table 3). 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 BRRP, with an annual predicted increase of 5 percent, resulting in an estimated benefit of Tk 23.89 million in Year 10 (Table 4).

The estimate of Haque *et al.* (1997) is only for the Hazaribagh area. However, people's health in areas other than Hazaribagh is expected to benefit from the restoration program. 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 value of savings on medical costs over the whole of the study area was estimated conservatively by extrapolating from Haque *et al.* (1997)'s lower bound estimates[14].

3.2.3 Cost Saving for Domestic and Industrial Water Uses

Improved water quality in the Buriganga River would save money on total water treatment costs, making it cheaper for the water authority (i.e. Dhaka Water and Sewerage Authority or DWASA) to supply water for domestic and industrial uses. It was assumed that in the long term the Buriganga River water would 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, with a current treatment capacity of 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. The current cost of treating a thousand litres is Tk 4.40, while 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 . It is very hard to estimate any figure for cost saving from the restoration of the Buriganga River water without a detailed technical study. No such information is available. The DWASA applies a rule of thumb to estimate the cost saving for the restoration 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. 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 4. Although the river water becomes cleaner through time and the treatment cost is likely to decline significantly in later years, it is assumed that the annual costs of treatment during the program period will remain unchanged.

[14] 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.

Ground water is currently the main source of water supply in Dhaka City, but 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 the ground water level causes tube wells to be installed deeper and in some instances it becomes very 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 shortages during the summer months. Finally, and most importantly, due to massive arsenic contamination of ground water throughout the country, the Bangladesh 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 daily to the city dwellers out of the total demand for 1600 million litres. It uses 349 deep tube wells and two surface water treatment plants, including the one installed in 2002. The DWASA's two proposed new treatment plants at Saidabad, 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 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. 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, out of which 939.1 MLD (46.96 percent of the total supply) will come from surface water sources. By Year 10 of the BRRP, the total estimated cost saving from water treatment will reach Tk 313.50 million (see Table 4).

3.2.4 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 always been 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.

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 Bangladesh Inland Water Transport Authority (BIWTA), it is estimated that a total of Tk 2.3 million of 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 in Table 4, to measure the total benefits of the BRRP and for the projection over the whole 10-year period (i.e. for Year 1 to Year 10).

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 should be related to the overall improvement of the river.

3.2.5 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 economic benefit of recreation, where this might be estimated as potential revenue earnings for the government from this sector. Nonetheless, an estimate was 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. It was assumed that the number of visitors and users of the proposed facilities in and around the Buriganga River would be at least five times bigger than the Shishu Park as they would cover a much larger recreational area and offer a wider range of activities. By Year 5 of the BRRP, 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 2 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 4.

3.2.6 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. The lack of baseline information on catch rates or harvest in the Buriganga River makes it hard to estimate the potential fish species and fish populations which may inhabit such a riverine environment after the implementation of the restoration program[15]. However, it is certain that any water quality improvement will directly benefit fish production. In the absence of more information, the expected benefits were estimated again using the benefit transfer approach.

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 restoration program, the Buriganga River is assumed to achieve an

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[15] In the absence of any estimates in 2001, the level of fish production in the Buriganga River was assumed to be zero for this study. However, a recent study conducted by the Institute of Water Modelling estimates a fish production of 21.41 tonnes per year, which is still insignificant (reported in Islam and Alam, 2004).

equivalent productivity within five years and a further 5 percent annual growth thereafter until Year 10. The market value of the increased fish production was estimated at Tk 0.89 million per year from Year 5 of the BRRP. For pricing, an average market price of Tk 120/kg of fish is used, disregarding price differences between species. This price was used to estimate the increased fish production for the whole program period, as shown in Table 4.

3.3 Estimates of Total Benefits

The non-market and market benefits, as explained above, were combined to estimate the total benefit of the BRRP. The respondents' contribution in terms of time was also priced. All components of the TEV from the potential restoration of the Buriganga River with estimates based on constant 2001 prices are compiled in Table 4. The estimation of various benefit components as described above is for a single year. In Table 4 this has been extended for the period of the program (i.e. Year 1 to Year 10).

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 4. The total economic benefit of the BRRP is estimated to be Tk 388 million (US$ 6.80 million) in Year 1, rising to Tk 1,805 million (US$ 31.66 million) by the end of the BRRP period (i.e. in Year 10). This is a very significant figure. The share of total non-market benefits is 47.31 per cent for the period Year 1-Year 10. Also, the WTC_T accounts for 54.62 percent of total non-market benefits. This clearly indicates the need to: (1) account for all benefits when estimating the value a river has to a community and (2) that the share of the residents' contributions (be it through payments or time/labour) is too significant to be ignored.

In the case of the Buriganga River, half of the expected benefits of the restoration program are marketed. 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). Market benefit is higher mainly because of land and rental values in Dhaka City. Dhaka is one of the most densely populated capital cities in the world. The land values there differ greatly to other cities, in some cases several times. In the case of other rivers, the share of market benefit to the total benefits might be considerably smaller. In such cases, the restoration may invariably appear to be 'non-economic'. This study reveals that the whole range of benefits, both market and non-market, is relevant to policy making.

A comparison with studies conducted in developed countries shows that the share of non-use value is often higher than the use value. In the case of the BRRP, however, the share of use benefits is higher than that for non-use benefits. The reason may be, other than pulling of market benefits by land value, 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). This hypothesis however requires further research.

Table 4: *Estimates of total benefits*

Table 4: *Total benefit of the Buriganga River cleanup program over 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			2.3	2.5	2.6	2.8	3.0	3.2	3.5	3.7	23.6
Increased fish production[b]	Benefit transfer					0.9	0.9	1.0	1.0	1.1	1.1	6.1
Cost saving for domestic & industrial water uses[c]	Market data		10.7	43.5	43.5	133.5	133.5	133.5	133.5	133.5	313.5	1078.7
Increased value for recreation and tourism activities[d]	Market data					2.5	2.6	2.8	2.9	3.0	3.2	17.0
Increased housing & land values[e]	Secondary data					641.9	674.0	707.7	743.1	780.2	819.2	4366.0
Improved health benefit[e]	Secondary data					18.7	19.7	20.6	21.7	22.8	23.9	127.3
Total market benefit			10.7	45.8	46.0	800.1	833.5	868.6	905.4	944.0	1164.6	5618.7
Components of non-market benefit[f]:												
WTC$_M$	CVM	175.9	186.0	196.7	207.9	219.8	232.4	245.8	259.8	274.7	290.5	2289.6
WTC$_T$	CVM	270.0	285.5	301.9	319.2	337.4	356.8	377.2	398.9	421.7	445.9	3514.4
WTC$_T$ (adjusted)		211.8	223.9	236.7	250.3	264.7	279.8	295.9	312.8	330.7	349.7	2756.4
Total non-market benefit (adjusted)		387.7	409.9	433.4	458.2	484.5	512.3	541.6	572.7	605.5	640.2	5046.0
Total benefit (excluding sales revenue)		387.7	420.6	479.2	504.2	1284.6	1345.8	1410.2	1478.0	1549.5	1804.8	10664.7
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%.

4.0 Conclusions

Investment for environmental health is important for achieving sustainability, particularly in the context of public sector investment in developing countries. Natural resource depletion and environmental degradation can be limiting factors for future economic growth. A living river such as the Buriganga has enormous significance for the survival and growth of Dhaka City in particular and the economy in general. By destroying the carrying capacity of the existing resources, heavy costs are likely to be imposed on current and future generations. The identification of community preferences for environmental use can minimize inefficient allocation of resources. Economic valuation can play an important role integrating non-market benefits into decision making in resource use and allocation.

The case study of the Buriganga River illustrates that a failure to appreciate non-market benefits means policy makers underestimating the benefits of environmental protection and restoration programs if decisions are made only on market information. In this paper it has been argued that incorporation of non-market values in the benefit estimation process is needed to make the concept of sustainability operational. A failure to account for such benefits could lead to gross under-estimation of the desirability of providing public funding for the restoration of vulnerable rivers in Bangladesh. Although the findings are based on a single river in Bangladesh, the analytical framework has the potential to be widely applicable to all cases where natural resources are subject to degradation due to missing markets or market imperfections. Public sector investment in developing countries such as Bangladesh needs redirection to respond to emerging environmental problems such as water and air pollution and global warming. The proposed method can significantly facilitate such decision making.

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