DETERMINING THE ECONOMIC VALUE OF A WETLAND OF DHAKA

by

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It is hereby declared that this thesis or any part of it has not been submitted elsewhere for the award of any degree or diploma.

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Rezwana Rafiq

Dedicated to my beloved parents

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Abstract

Wetlands are the most productive ecosystems on earth. They provide many important services to human society. But most of these services are not evaluated in a monetary term. As a result, loss of wetland for urban expansion is a common phenomenon in all over the world.

The recent trend of development in Dhaka has also becoming an alarming threat for the existence of wetlands. Unplanned expansion of Dhaka is encroaching flood plains, depression and storm water retention areas by land filling. As a result, the city is becoming more vulnerable to river flooding and heavy rainfall. It is now high time to assess the economic values of various functions and services provided by the conserved wetlands to prevent its subsequent losses.

In this research, an attempt is made to valuate various direct and indirect use benefits of wetland. Nearly 11 sq. km area of the western flood plain of Dhaka is selected as the study area. This area is mainly a low lying flood flow zone designated by Detailed Area Plan (DAP). Direct use of this flood plain includes agriculture, fisheries and recreation. Among various indirect use benefits of flood plains, only ground water recharge function and flood control function are selected for the study. This site is valued as fertile agricultural land in dry season. Local people cultivate paddy during this season from the month of November to April. During the wet season from the month of May to October this area becomes a productive source of fish farming. Variety of fishes is available in this period which is a significant source of earnings for local people. As the site is turned into vast water body in monsoon, at that period it also becomes a place of attraction for city dwellers. The visitors mostly enjoy the scenic beauty of the countryside and also the boating facilities.

In the study, the economic benefits of agricultural products and fisheries of the site are derived from Market Price Method. In this method, the prevailing market prices of paddy and fishes traded in domestic markets are used for valuation. Required data for the valuation of agricultural products and fisheries are obtained through focus group discussion of Participatory Rural Appraisal (PRA) method. A cost-benefit analysis is also conducted for these productions. To valuate the recreational benefits of the site, Individual Travel Cost Method is applied. It is a demand based model in which the value an individual attach to a site is estimated from the cost they expend in travelling to that site. For this purpose, an extensive questionnaire survey with nearly 310 user responses is conducted. Flood control function of the area is determined by Damage Cost Avoided Method in which the potential flood loss due to the absence of the flood plain is calculated. In valuing the ground water recharge function, at first per year recharged quantity of water is calculated and then it is priced. Finally, the estimated total economic value of the site amounts to Tk 0.71 million per hectare.

Investigating the economic benefits of a wetland is the first step in the direction of formulating a comprehensive wetland conservation plan. Thus, this research would help the policy makers, environmentalists, socialists and planners to figure out the yearly benefits that can be earned from various services and goods of wetland. This would guide the government in identifying the sectoral priorities regarding conservation of wetland and to formulate strategies for the short term as well as the long term effective management of wetland of Dhaka.

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Chapter 1: Introduction

1.1 Background of the Study

Economic valuation of environmental resources can be defined as the attempt to assign quantitative values to the goods and services provided by these resources, whether or not market prices are available to assist. It quantifies the benefits of environmental projects and policies, so that they are more transparent and can be given due and appropriate weight in any decision making process or cost benefit analysis (Garrod and Willis, 2001). Economic valuation is a powerful tool to aid and improve wise use and management of global wetland resources by providing a means for measuring and comparing the various benefits of wetlands (Barbier et al., 1997).

Wetlands are very rich and diverse ecosystems in the world. According to Ramsar International Wetland Convention, wetlands are defined as a wide variety of habitats such as marshes, peatlands, floodplains, rivers and lakes, and coastal areas such as salt-marshes, mangroves, and sea grass beds but also coral reefs and other marine areas no deeper than six meters at low tide, as well as human made wetlands such as waste-water treatment ponds and reservoirs (Ramsar Convention Bureau, 2000).

The economic value of wetland includes both use and non-use values. Wetland use values are associated with a diverse and complex array of direct and indirect uses. Direct uses of wetlands involve both commercial (marketed value) and non-commercial activities whereas indirect use values are unmarketed, go financially unrewarded and are only indirectly connected to economic activities. The benefits provided by the wetlands are innumerable and these values are often lost through inappropriate development or used inefficiently due to lack of knowledge about the vital functions performed by them. As wetlands and the functions they provide become increasingly scarce, the conventional view of treating wetlands as a free resource is being increasingly questioned. The lack of pricing of wetland functions is one of the main determinants of inefficient, inappropriate and excessive use of wetland (Turner et al., 2003). Many researchers have also extensively presented and

described this issue in their literature (Barbier et al., 1997; Ramachandra et al., 2005; Boyer and Polasky, 2004 and Nhuan et al., 2003).

Dhaka, the capital of Bangladesh is experiencing rapid population growth day by day. To meet the need of this ever increasing people, city is expanding outward, but in an unplanned way. This situation has largely contributed to the encroachment of wetlands by land filling for residential, commercial and other infrastructure development purposes. In 2005 only 16.9% of Dhaka's land area remains as wetland. If the current rate of loss of wetland continues, before the year 2035 all temporary wetlands of Dhaka will disappear (Islam, 2008). Due to the subsequent loss of wetlands in and around Dhaka, it has become more vulnerable to river flooding and heavy rainfall as these wetlands act as the natural retainer of storm water, channelize the water and maintain natural drainage system. Moreover, the adverse impact of climate change will prone Dhaka to frequent flooding and heat stress in the nearer future. Along with other response measures it is very necessary to conserve the wetlands in and around Dhaka to combat against these devastating disasters. Hence, the understanding about the conservation and wise management of these wetlands is of much importance in the context of environmental and economic vulnerability.

In Dhaka Metropolitan Development Plan (DMDP): Structure Plan (1995-2015) and Urban Area Plan (1995-2005) certain areas are defined as main flood flow zones which are either permanently (rivers) or seasonally flooded (flood lands) and as sub-flood flow zones which are either temporarily or seasonally flooded (flood lands) (DMDP, 1997). Whereas in Detailed Area Plan (DAP), the areas under main flood flow zones and sub-flood flow zones are brought under a broad category termed as flood flow zones. But in all these plans there is no specific management policy or way to conserve such wetlands. The lack of appropriate pricing of the benefits of these wetlands leads to its low-prioritization in national conservation strategy.

Several initiatives are found in the recent research approaches regarding the process, trend, context and consequences of loss of wetland in different parts of Dhaka Metropolitan Area (Islam, 2008; Sultana, 2005; Hoque, 2004 and Satu et al., 2004). The research work of Billah and Khan (2000) focuses on estimating total economic benefits of Tanguar Haor but the unavailability of data confines their study only to

the application of direct methods for estimating economic benefits of some limited resources such as agriculture and fisheries on the basis of some secondary sources (Billah et al., 2000). Valuation is the only one element in the effort to improve the management of wetlands (Barbier et al., 1997). But no research has been conducted concentrating on the economic valuation of wetlands of Dhaka.

In this regard, this study evaluates the economic worth of direct and indirect use benefits of a wetland of Dhaka to depict a comprehensive understanding of the economical benefits that can be extracted through the wise management of wetlands.

1.2 Objectives of the Study

To determine the economic valuation of the wetland the following objectives are formulated:

- To study existing direct and indirect use benefits of wetlands of the study area.
- To assess the economic values of direct and indirect use benefits of wetlands of the study area.

1.3 Rationale of the Study

Despite the increasing recognition of the need to conserve wetland, losses have continued. The main reason is that wetlands have traditionally been considered to be of little or no value, or even at times to be of negative value. This lack of awareness of the value of conserved wetlands and their subsequent low prioritization by the decision-making process has resulted in destruction of wetlands.

Although wetlands provide many important services to society, but unfortunately many of these services are not bought and sold on markets and thus are generally ignored in private and public development decisions. In the absence of regulation, most private landowners will decide to fill wetlands because from development private benefit is typically far greater than the value captured from preserving the wetland. But the fact is if one can derive the total valuation by adding up all the

services generated by a wetland, then the benefits might outweigh the value of development (Boyer and Polasky, 2004).

It is a difficult task to justify the protection of wetland in a city like Dhaka where pressure on land is very high and market force is dominant. The traditional wise use of wetland of Dhaka reflects its harmonious co-existence with its inhabitants that means to leave it in its natural state (Islam, 2008). The alarming rate of loss of wetland has made the environmentalists, socialists and planners very much concerned about this issue. They are trying to raise their voice against the conversion of wetland by private land developer companies. The debate against the conversion of wetland will be more valid if the opportunity costs of wetland loss that means the conservation benefits forgone from the conversion of wetland can be quantified and evaluated.

In this research, the direct and indirect use benefits of a wetland of Dhaka are identified and their economic values are assessed. It will help the environmentalists, socialists, planners and the policy makers to figure out the yearly benefits that can be earned from various services and goods of wetland. Taking into account of the opportunity cost of wetland loss will lead to a lower level of conversion of wetland.

This valuation will also help the decision-makers to take account of many competing interests in deciding how best to use wetland. Information on the economic values can greatly assist in identifying the effective policies and sectoral priorities regarding conservation of wetlands of Dhaka. For example, if the government decides to conserve wetland of Dhaka, then this research will provide valuable information about the amount of compensation that to be given to the landowners of the wetland.

Economic valuation incorporating environmental aspects will help in evaluating developmental projects, programs and policies. Moreover, the valuation techniques used in the study will be a guidance to assess economic valuation of other wetlands of Dhaka.

1.4 Scope and Limitations of the Study

Although the total valuation of the wetland consists of both use and non-use value but in the study only use values are estimated. The main problem is while use values can be measured by market prices, non-use values cannot because they are not traded in the market. The quantification is further complicated in context of developing countries such as Bangladesh, where a large share of the components of 'total economic values' do not have established markets or secondary data source. As mentioned earlier that no significant research is still conducted focusing on this issue and there is no official record available, it takes much time and effort to collect the primary data for the use benefits discussed in this research. Due to these facts the study only covers three direct use benefits namely agriculture, fisheries and recreation and two indirect use benefits- ground water recharge and flood control functions of wetland.

Due to the outstanding economic return of the housing sector, there is a growing trend to invest in this sector by real estate developer companies in Dhaka. The developers usually prefer low lying land especially the designated flood flow zones extended around the city as they can buy it at a cheaper rate from the local owners. If all the use and non-use values could be estimated and development cost and benefits by the developers could be collected then the estimated conservation benefits could be made comparable with the returns derived from the conversion of wetland. The present study can work as a backdrop for such kind of research.

1.5 Organization of the Study

The research comprises of eight chapters. The first chapter describes the research background, rationality of the research, its objectives, scopes and limitations.

In the second chapter the theoretical framework that the study is based on is presented. The concept of economic valuation of wetland, different valuation methods, advantages and disadvantages with the chosen method is discussed here.

This chapter also represents the findings of some national and international researches conducted on the similar issue.

The third chapter of the study outlines the methodological framework, the methods used in the study for valuation and why these methods are chosen here. The forth chapter includes various direct and indirect use benefits of the site that are identified to carry out the study.

The next four chapters, from chapter five to chapter eight provides detail description of the valuation method, data collection and data analysis process for agricultural products, fisheries, recreational site and flood control and ground water recharge functions respectively.

The last chapter of the study presents major findings, its policy implications and conclusion based on the results from the previous chapters.

Chapter 2: Theoretical Framework

2.1 Introduction

An extensive relevant literature is reviewed in this study from various research reports, theses, newspapers, journals, magazines etc and internet is searched to develop the theoretical base to the study and to familiarize with the concept of economic valuation, different environmental pricing techniques, valuation of wetland etc. A review of some studies is outlined in this chapter.

2.2 Wetland

Wetland is one of the most important ecosystems on earth and very dynamic in nature. Different organizations all over the world have set their definitions for clear understanding of wetland. As a result there is no universally agreed classification of wetland (Islam, 2008). Most universally accepted definition has been set by Ramsar Convention. According to Ramsar convention wetlands are defined as "areas of marshes, fen, peatlands, floodplains, rivers and lakes and coastal areas such as salt-marshes, mangroves and sea grass beds but also coral reefs and other marine areas no deeper than six meters at low tide, as well as human made wetlands such as waste-water treatment ponds and reservoirs" (Ramsar Convention Bureau, 2000).

Wetlands are very important ecological systems that contribute to a wide variety of biological, social and economic benefits. Wetlands provide many important services to human society such as prevention of storm damage, flood and water flow control, water purification, retention of nutrients, ground water recharge and provide habitat for a variety of species. They are also valued for recreational and aesthetic reasons (Islam, 2008; Barbier, 1994; Boyer and Polasky, 2004).

According to Mitch and Gosselink (1993), wetlands are termed both as 'the kidneys of the landscape', because of the functions they perform in the hydrological and chemical cycles and as 'biological supermarkets' because of the extensive food webs and rich biodiversity they support.

Wetland systems directly support people by providing goods and services. People use wetland soil for agriculture, they catch fish from wetland to eat, they cut wetland trees for timber and fuel-wood, they use wetland as a means of travel. Wetlands can also be directly used for recreation purpose such as bird watching or sailing, or scientific study. Apart from the direct benefits, people are benefited through a wide variety of indirect wetland functions. For example, when flood water flows out over a floodplain, the water is temporarily stored there. This reduces the peak water level of the river and thus makes the dwellers of the downstream benefited. By reducing wave energy and stabilizing shorelines, the wetland reduces the chances of property damage. As wetlands recycle nitrogen, they improve water quality downstream. Wetlands also naturally recharge the ground water level and thus act as a source of water (Barbier et al., 1997).

2.3 Economic Values of Wetland

The economy and the environment are inextricably linked. As resources are scarce, choices have to be made about how to use them optimally and effectively. The basic fact is that resources used to meet one choice or alternative cannot be used to meet another. Ecological resources and services are so varied in their composition that it is often difficult to examine them on the same level. Although challenging, it allows the planners and policymakers to make decisions based on specific comparisons, typically monetary, rather than some other arbitrary basis.

Environmental valuation includes an extensive literature on methodologically rigorous procedures for valuing environmental goods and services (Hearne, 1996). In other words, environmental economics defines the conditions in a variety of contexts which is required to secure the most efficient allocation of scarce resources (Turner et al., 2003).

Economic valuation refers to valuing goods and services in economic terms. Economic values are useful in making economic choices, which involve trade-offs from alternative allocation of resources. The theory of economic valuation is based on individual preferences and choices because economists assume that individuals, not the government are the best judges of what they want (Mahat, 2004).

Economic valuation of wetland means to quantify the value of goods and services provided by the wetland. The total economic value of wetlands include both use and non-use values. Use values are grouped into direct use value and indirect use value (Detail in Chapter 4).

2.4 Methods of Economic Valuation

There are many valuation techniques to assess the economic value of goods and services provided by wetlands. It is as important to assess the products of wetland which have marketed value as to the ecological functions result in goods and services which are not traded in markets. Because the latter services, which are not marketed usually remain un-priced and gone un-recognized. Considering all these, a range of valuation techniques of wetland functions, the underlying theory and their practical implications are discussed in detail in many researches (Turner et al., 2003; Freeman, 1993; Hanley and Spash, 1993; Barbier et al., 1997 and Pearce and Moran, 1994). Different valuation techniques used for valuing wetland functions are presented in the following table:

Table 2.1: Different Valuation Methods Relating to Wetland Functions

Valuation Method	Description	Direct Use Values	Indirect Use Values	Non-Use Values
Market Analysis	Where market prices of outputs and inputs are available. Marginal productivity net of human effort/cost. Could approximate with market price of close substitute. Requires shadow pricing	✓	✓	
Productivity Losses	Change in net return from marketed goods: a form of (dose-response) market analysis	✓	✓	
Production Functions	Wetlands treated as one input into the production of other goods: based on ecological linkages and market analysis		✓	
Public Pricing	Public investment, for instance via land purchase or monetary incentives, as a surrogate for market transaction	✓	✓	✓
Hedonic Price Method (HPM)	Derive an implicit price for an environmental good from analysis of goods for which markets exist and which incorporate particular environmental characteristics	✓	✓	

Travel Cost Method (TCM)	Costs incurred in reaching a recreational site as a proxy for the value of recreation. Expenses differ between sites (or for the same site over time) with different environmental attributes.	✓	✓	
Contingent Valuation Method (CVM)	Construction of a hypothetical market by direct surveying of a sample of individuals and aggregation to encompass the relevant population. Problems of potential biases	✓	✓	✓
Damage Costs Avoided	The costs that would be incurred if the wetland function were not present; e. g. flood prevention		✓	
Defensive Expenditures	Costs incurred in mitigating the effects of reduced environmental quality. Represents a minimum value for the environmental function		✓	
Relocation Costs	Expenditures involved in relocation of affected agents or facilities: a particular form of defensive expenditure		✓	
Replacement/ Substitute Costs	Potential expenditures incurred in replacing the function that is lost: for instance by the use of substitute facilities or shadow projects	✓	✓	✓
Restoration Costs	Costs of returning the degraded wetland to its original state. A total value approach; important ecological, temporal and cultural dimensions	✓	✓	✓

Source: Adapted from Turner et al., 2003

Turner et al. (2003) have presented a well organized and brief discussion about the valuation techniques of wetland in their research. According to them, the distinction between those valuation techniques which estimated benefits directly and those which estimate costs as a proxy for benefits should be clearly understood. The valuation techniques such as Damage Costs Avoided, Defensive Expenditures, Replacement/Substitute Costs or Restoration Costs suggest that the costs are a reasonable approximation of the benefits that society attributes to the resources. The assumption behind this is that the benefits are at least as great as the costs involved in repairing, avoiding or compensating for damage. These techniques are widely used because of their easy estimation process and availability of data, but at the same time their limitations in terms of the information they convey with respect to economic benefits should be considered.

While valuing the resources having market price, market distortions such as taxes or subsidies to provide shadow prices have to be considered to adjust the price,

otherwise they are likely to provide a relatively simple means of assessing economic value. Theoretically, the estimations based on market prices are not the same as the total economic value as they do not include the consumer surplus. In the valuation method termed as 'productivity losses', the assessment of losses in productivity is attributed to changes in the ecosystem. The ecosystem is incorporated as one of the inputs into the production function of other goods and services. In 'public price' method, the investment by public bodies in conserving ecosystem represent a surrogate for aggregated individual willingness to pay and the approximation of the value society places upon them (Turner et al., 2003).

In the absence of market prices, two theoretically valid benefit estimation techniques are hedonic price method and travel cost method, which are based on preference being revealed through observable behavior (Turner et al., 2003). Through hedonic pricing method, the economic value of an environmental improvement can be inferred from the price differential of certain environmentally sensitive characteristics associated with commercially marketed products (Ward, 2006). This method has potentials for valuing certain wetland functions such as storm protection, groundwater recharge in terms of their impact on land values, assuming that the wetland functions are fully reflected in land prices (Barbier et al., 1997).

The travel cost method, first proposed by Hotelling (1947) is one of the oldest methods in valuing non-marketed services. TCM is based on the assumption that the money and time that people spend for travelling to an outdoor recreational area indicates the site's economic value. That means, this method uses the travel cost as a proxy for the price of recreation. TCM recognizes that the cost of travel to the site affect an individual's frequency of visit to the site. From the frequency of visit and travel cost data, the demand model for the site can be constructed. The area under the estimated demand curve defines the value of the recreational site.

Contingent valuation method (CVM) is one of the important methods in environmental valuation, which is a stated preference technique. The main advantage of this method is that it gives empirical estimates of both use and non-use values of environmental resources. In this method people are asked hypothetically how much

they are willing to pay for something they value or are willing to receive in compensation for accepting deterioration (Garrod and Willis, 2001).

2.5 Various Appraisal Methods for Wetland Valuation

After quantifying the economic value of wetland, it should be placed in the appropriate appraisal framework. There are various appraisal methods such as cost-benefit analysis, environmental impact assessment, multi-criteria analysis and risk assessment. At initial stage of the study, appropriate framework for assessing cost and benefit should be determined. In cost-benefit analysis the most common methods for comparing costs and benefits are net present value, benefit-cost ratio and internal rate of return. As in the study, cost-benefit analysis is conducted, only the procedure of this analysis is described in this section.

(a) Net Present Value (NPV)

The net present value of a project is the summation of the present values of all the cash flows that are expected to occur over the life of the project (Chandra, 2004-05).

Net Present Value $= \sum_{t=1}^{n} \frac{C_t}{(1+r)t} -$ Initial Investment

Where, C_t = Cash flow at the end of the year t

n = Life of the project

r = Discount rate

The decision rule associated with the net present value criterion for a project is shown in the following table:

When NPV	Rule
> 0	Accepted
= 0	Indifferent
< 0	Rejected

(b) Benefit Cost Ratio (B/C ratio)

The ratio between the benefit and cost of the project can be referred to its benefit cost ratio. There are two ways of defining the relationship between benefits and costs:

Benefit Cost Ratio: BCR = $\frac{\text{PVB}}{\text{I}}$

Net Benefit Cost Ratio: NBCR = $\frac{\text{PVB}-\text{I}}{\text{I}}$ = BCR - 1

Where, PVB= Present value of benefits = $\sum_{t=1}^{n} \frac{C_t}{(1+r)t}$

I = Initial investments

The following decision rules are associated with them:

When BCR	NBCR	Rule
> 1	> 0	Accepted
= 1	= 0	Indifferent
< 1	< 0	Rejected

(c) Internal Rate of Return (IRR)

The internal rate of return is the rate of return earned on the initial investment made in the project. The IRR of a project is the discount rate which equates the present value of future cash flows with the initial investment (Chandra, 2004-05). It is the value of r in the following equation:

Investment = $\sum_{t=1}^{n} \frac{C_t}{(1+r)t}$

Where, C_t = Cash flow at the end of the year t

n = Life of the project

r = Internal Rate of Return (IRR)

Despite NPV's conceptual superiority, IRR is preferred over NPV because IRR is intuitively more appealing as it is a percentage measure. But there are some problems using IRR. One of them is at the situation when short term interest rates differ from long term interest rate. To overcome such problem Modified Internal Rate of Return (MIRR) is used (Chandra, 2004-2005).

The procedure for calculating MIRR is given below:

Step 1: The present value of the costs (PVC) associated with the project has to be calculated using the cost of capital (r) as the discount rate.

$$PVC = \sum_{t=0}^{n} \frac{Cash\ outflow_t}{(1+r)^t}$$

Step 2: The terminal value (TV) of the cash inflows expected from the project has to be calculated.

$$TV = \sum_{t=0}^{n} Cash\ inflow_t \times (1+r)^{n-t}$$

Step 3: Then MIRR have to be solved by solving the following equation:

$$PVC = \frac{TV}{(1+MIRR)^n}$$

2.6 Review of Some Previous Studies

Valuation of environmental resources is a relatively new area of research in developing countries and a very new approach for Bangladesh. A considerable number of researches have been reviewed covering the economic valuation methods of environmental resources specially for valuing market goods such as agriculture and fisheries and non-market goods such as recreational area associated with wetlands. A few more significant researches on these issues are discussed here.

Barbier et al. (1997) have provided guidance to policy makers and planners on the potential for economic valuation of wetlands and how such valuation studies should

be conducted in their research. They also include seven-step guide for undertaking economic valuation and finally provide some recommendations for future actions. The operational methods for ecosystem valuation with particular reference to the economics of wetland management are documented in detail in the study of Turner et al. (2003).

Boyer and Polasky (2004) have reviewed recent literature on non-market valuation as applied to wetlands, particularly on the value of urban wetlands. They have concluded that valuation studies can provide useful information about relative ranking of value. But without proper regulation and understanding of the incentives of private landowners whose decisions affect wetlands, even wetlands that have been shown to generate high value for society may be lost.

Costanza et al. (1989) have discussed the theoretical and practical problems of natural resource valuation and summarize the methods and findings for Louisiana wetlands. Their estimated current present value of natural wetlands in Louisiana is US$ 2429-6400 per acre.

Tang (2009) has assessed the recreational value of Yuelu Mountain Park in China by applying Travel cost method (TCM). Here the travel cost demand function is estimated by using basic count data travel cost model- Poisson regression, and survey data is collected on-site through questionnaire survey of 200 samples. An econometric analysis of the Periyar National Park in India has been made by Bulov and Lundgren (2007). They have estimated the recreational value of this park by TCM where the data is collected on a sample of 129 visitors of the park. The calculated consumer surplus from the demand function is US$ 15 billion.

Willis and Garrod (1991) have documented a clear distinction between ITCM and ZTCM and also made a comparative analysis among demand models and discussed their best suited conditions. Gurluk and Rehber (2007) have estimated recreational value for a bird refuge at Lake Manyas in Turkey by using TCM. With rigorous analysis of demand curves developed from zonal travel data, they have concluded that the recreational value of the site is 103,320,074 USD annually. The difficulties

of travel cost method are more clearly and elaborately stated in the research of Fleming and Cook (2007).

Ramachandra et al. (2005) have tried to assess the economic valuation of three lakes namely Hebbal, Amruthalli and Rachenahalli of Bangalore district in India. They have also pointed out the role of the stakeholders especially public and private sector in managing the ecosystems in a sustainable manner. Alam and Marinova (2006) have evaluated Buriganga, a vulnerable river in Bangladesh to illustrate that a failure to appreciate market as well as non-market benefits could lead to gross underestimation of the desirability of providing public funding for environmental protection and restoration program of such wetlands. Their estimated total benefit for the Buriganga river cleanup program over 10 years is around US$ 132 million.

Billah and Khan (2000) have estimated the total economic benefits of Tanguar Haor. They have made their analysis by collecting data from secondary sources. Due to the data unavailability, their research have only been confined with estimating the economic benefits of some direct uses of wetland such as fish production, crop production, fuel-wood and grazing. And for this reason the comprehensive total economic values of wetland benefits could not be derived in that research.

All the researches mentioned above are very relevant to the current research of determining the economic value of a wetland of Dhaka city. This research is the first attempt in estimating the total economic value of a wetland in Dhaka while the conservation of the existing wetlands here is a burning issue as their present existence is under immense threat. This study covers different direct and indirect use benefits of wetland as well as detail data collection and data analysis procedures for evaluating the economic benefits of those direct and indirect uses. It is hopeful that this research would help the government in taking national conservation actions regarding wetlands.

Chapter 3: Research Methodology

3.1 Introduction

To fulfill the objectives of the research, the whole study has been carried out through an orderly step by step process. This chapter illustrates these sequential steps. The detail data collection, sampling and data analysis processes required to valuate the selected direct and indirect use benefits of wetland are discussed in their concerned chapters.

3.2 Methodology of the Study

The stepwise research methodology of the study is discussed below:

3.2.1 Literature Review

Extensive relevant literature from both published and unpublished sources like books, national and international journals, reports, web documents has been reviewed to develop the concept of the research, to formulate the objectives and to have a better understanding of the need of economic valuation of wetland, valuation techniques, its indicators, present condition of wetland of Dhaka, wetland management issues etc.

3.2.2 Selection of the Study Area

According to the permanency and depth of water, Dhaka has different categories of wetland. This study only focuses on the flood plains of Dhaka. Flood plains refer to areas that undergo periodic flooding as river channel overflows with flood water (Billah and Khan, 2000). To conduct the study, a total area of 2656.355 acre or around 11 sq.km of flood plains or flood flow zones demarcated in Detailed Area Plan (DAP) in Goran Chatbari and Uttar Kaundia mouza have been selected. The whole area of Uttar Kaundia mouza is designated as flood flow zones in DAP which covers 2594.789 acres of land. On the other hand in Goran Chatbari mouza, 61.566 acres of land are fallen within designated flood flow zones (Map 3.2). These two

mouzas are extended from approximately 23˚47' latitude to 23˚50' latitude and from 90˚18' to 90˚21' longitudinal area.

These areas are situated at the western part of Dhaka city and is low lying cut across by Turag river and its khals and are designated by the Structure Plan as Flood Plains (Map 3.1). It is under the Special Planning Zone (SPZ) 17.3 (Flood Zone West) (DMDP, 1997). The average elevation of the study area is around 3 meter. This area retains water for about 5 to 6 months. In addition to river flood water they also store huge volume of rain water in every monsoon.

The study area has been selected considering the following criteria:

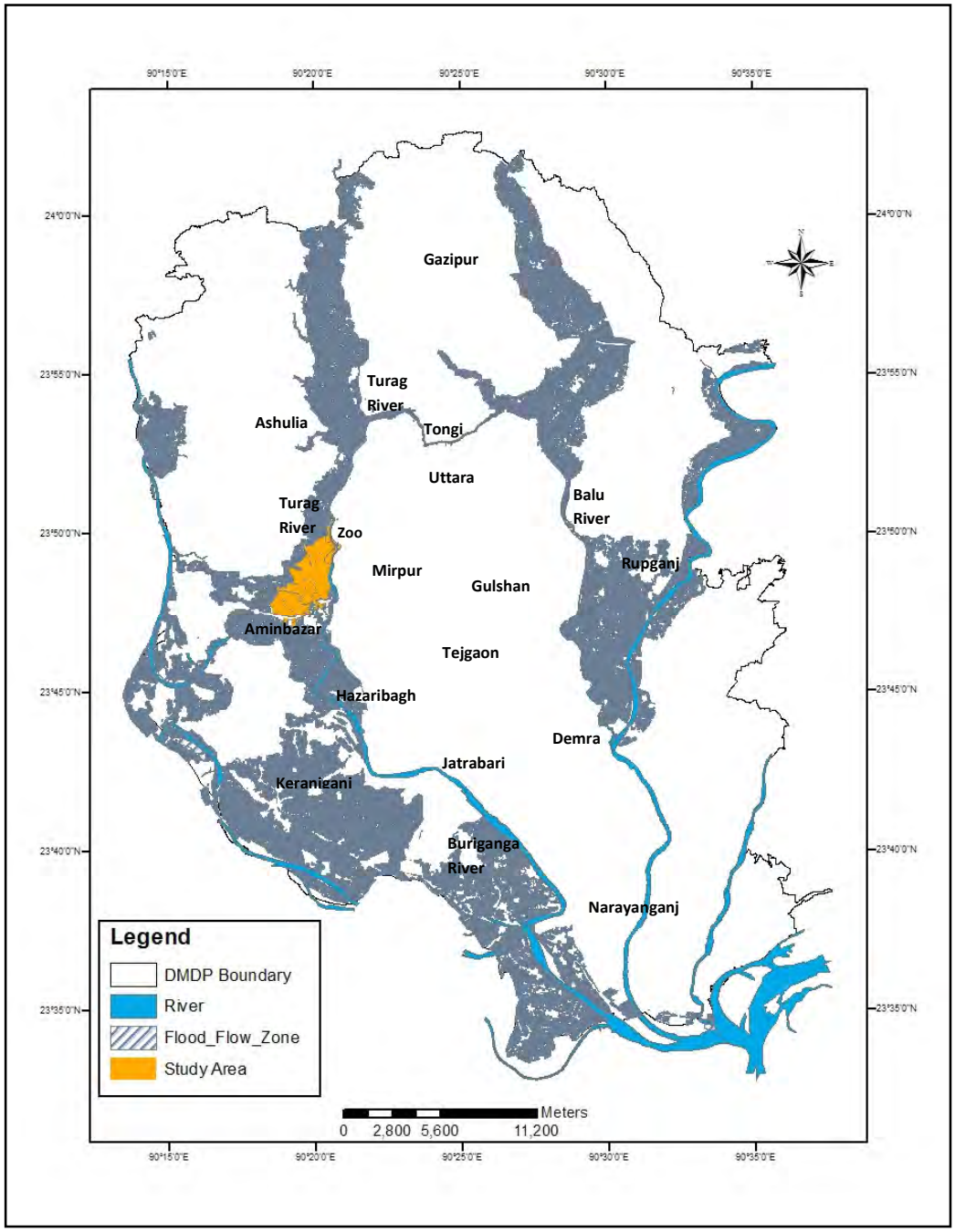
- The study area is located at the designated flood flow zones where any type of land filling as well as conversion of land is strictly prohibited (DMDP, 1997).

- This site is used as highly productive agricultural land in dry season and also productive for fisheries in wet season. In addition it provides scenic beauty and act as an important recreational zone for the city dwellers. To assess various direct benefits including the recreational use benefits of flood plains, this site is chosen.

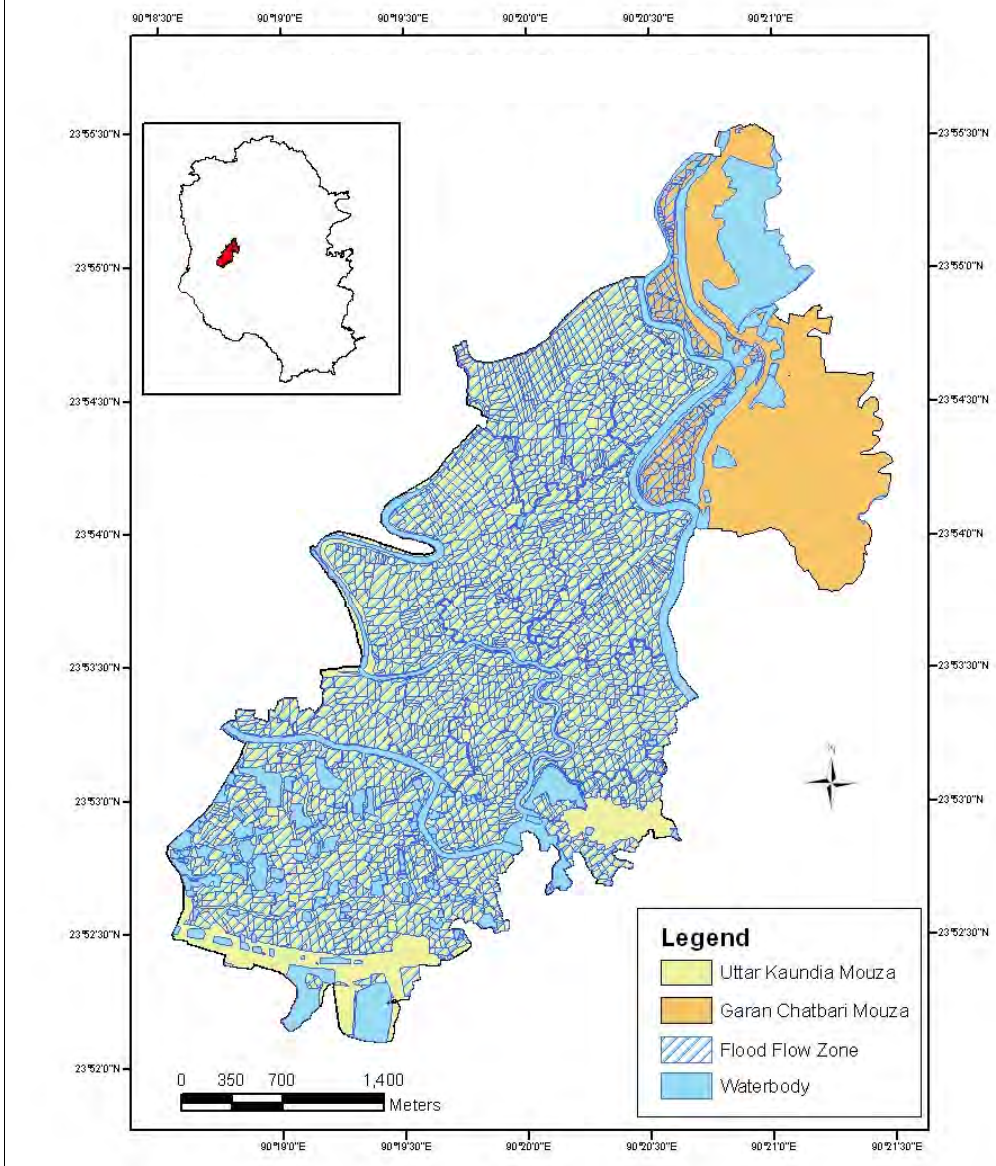
3.2.3 Selection of Appropriate Assessment Approach

At the first step in the evaluation process, the appropriate economic assessment approach has been selected. Among three approaches: impact analysis, partial valuation and total valuation, total valuation approach has been chosen for the study. Impact analysis is suitable if the problem is a specific external impact and partial valuation is suitable if the problem is the necessity of making a choice between wetland use options whereas total valuation is suitable if the problem is more general that means when there is a need to develop a national conservation strategy the assessment of the total net benefits of the wetland system will be appropriate (Nhuan et al., 2003).

Map 3.1: Location Map of the Study Area



Map 3.2: Designated Flood Flow Zone of the Study Area



As the aim of the study is to determine the worth of the wetland as a conserved area and to guide national conservation strategy, total valuation method is selected. Total economic value can be expressed as: TEV= Direct use value + Indirect use value + Non-use value.

3.2.4 Identification of Direct and Indirect Use Benefits

The economic value of wetland includes both use and non-use values (Detail in Chapter 4). Typically, use values involve some human 'interaction' with the resource whereas non-use values do not. Wetland use values can be derived from many direct and indirect uses. For both time and resource constraints, in this research total economic value of wetlands is derived from only direct and indirect use benefits.

In the study among various direct and indirect use benefits of wetland, agriculture, fisheries and recreational uses are selected as direct use benefits and ground water recharge and flood control functions are selected as indirect use benefits as these use benefits are more dominant in the study area (Detail in Chapter 4).

3.2.5 Selection of Economic Valuation Techniques

After identifying the components of wetland, appropriate valuation techniques are selected by which these can be valuated. The choice of valuation method that can be employed to estimate the economic value of the goods and services of wetlands are depends on the time, resource, availability of data and overall the choice of the analyst. Some methods are theoretically preferable while some are easier to determine in practice (Turner et al., 2003). It is comparatively easier to valuate the goods and services traded in markets by their market prices, but it is difficult to quantify the services or functions whose values are reflected in the economic activities they support. The non-market services or functions cannot be evaluated as the same way as market goods are analyzed by the quantities and prices in the market.

'Market Price Method' is a good measure of economic values of those environmental services which are bought and sold in commercial markets (Ward, 2006). As agriculture, fisheries uses have marketed values, these use benefits are valuated by

this method. In this study in case of both agricultural products and fisheries 'farm gate price' or 'price at first sale' is used for their valuation. Moreover, a cost-benefit analysis is conducted in which the annual benefit and cost of producing agriculture and fisheries are calculated (Detail in Chapter 5 and Chapter 6)

For valuing recreational use benefits of the study area 'Travel Cost Method' (TCM) is selected. This is one of the revealed preference approaches which are based on actual behavior of people in actual conditions rather than what people say they would do under hypothetical conditions (Ward, 2006).

Another valuation technique like 'Contingent Valuation Method' (CVM) could be applied in such case. But the problem in this method is one of the stated preference approaches where people are asked hypothetically how much they are willing to pay for the use of a good or service and has both strategic and operational biases (Pearce and Turner, 1990). Moreover, according to Hanley and Spash (1993), TCM is now a well established technique for valuing the non-market benefits of outdoor recreation resources. For these reasons TCM is selected in the study for valuing recreational benefits of the study area.

The basic principle of TCM is that the value people attach to a recreational site can be estimated from the cost they expend in travelling to that site. Such expenditure includes travel cost, entry fee, on-site expenditure etc. TCM applies a questionnaire survey where data are collected on the number of trips to the site and the different costs in reaching to the site. These costs are then be used to derive the demand function as well as the demand curve for the site. It is expected that the higher the cost of reaching a site, the lower amount of visits will be made to the site. From the demand curve consumer surplus is calculated. The sum of the direct cost and the consumer surplus is regarded as the price of that site.

There are mainly two types of travel cost models, the individual model (ITCM), where the dependent variable is the number of trips made per year by individual users of a recreational site and the zonal model (ZTCM), where the dependent variable is the number of trips made to the site by the population of a particular region or zone (Fleming and Cook, 2007).

In the study individual travel cost method is selected instead of zonal method. There are some factors which influence to rely on ITCM and discard ZTCM. Individual estimation is more statistically efficient than zonal data as individual travel cost method takes more account of the inherent variation in the data rather than relying on zonal aggregated data. Another reason for choosing individual approach over zonal approach is that individual trip data can estimate trip generating function by using a smaller number of observations than the zonal data. Moreover, ITCM collects much more information about individual visitors and therefore provides relatively closer travel cost approximation of true consumer surplus compared to zonal model (Garrod and Willis, 2001).

Benefit of ground water recharge function is derived from the recharged quantity of water from the site and the pricing of that quantity of water. Flood control benefit is estimated by applying Damage Cost Avoided method. In this method the potential damage due to flood is estimated assuming that damage would occur in the absence of wetland in its present form. Flood damage is estimated by calculating the area of inundation and cost of damage in that area. In many researches while estimating benefits of both of these functions Contingent Valuation Method (CVM) is used. But in this research this method is not applied because of its previously mentioned limitations.

3.2.6 Collection of Data and Information Required for Valuation

Data will be collected from both secondary and primary sources to fulfill the research objectives.

(a) Primary Data Collection

Data that are required to value the economic benefits from agriculture, fishing are collected from focus group discussion of Participatory Rural Appraisal (PRA) Method (Detail in Chapter 5 and Chapter 6). An extensive questionnaire survey is conducted to collect data on the visitor's socio-economic characteristics and travel pattern required to value the recreational benefit. The field survey is carried out for one month and during two weekends (Friday and Saturday) of a week. Questionnaire

design, sampling strategy and questionnaire survey strategy for the survey are discussed in Chapter 7.

(b) Secondary Data Collection

From different organizations such as Bangladesh Water Development Board (BWDB) and Dhaka Water and Sewerage Authority (DWASA) necessary data on Area of wetland, existing land use, depression of land, price of water etc are collected to evaluate the benefits from ground water recharge and flood control functions of wetland (Detail in Chapter 8).

3.2.7 Quantification of Economic Values

All the collected data are compiled and analyzed by using MS Excel, SPSS and GIS software. In case of estimating recreational use value a demand function as well as a demand curve is developed.

After calculating all the benefits of wetland, these values are added to estimate the total economic value of the wetland. At last the policy implications of this economic value are discussed.

Chapter 4: Direct and Indirect Use Benefits of the Site

4.1 Introduction

The economic value of wetland is measured by the summation of many individuals' willingness-to-pay for its goods and services. Based on different types of goods and services provided by wetland, its total economic value includes both use and non-use values. Use values involve some human interaction with a wetland's resources and services whereas non-use values do not. Wetland use values can be derived from many direct and indirect uses of wetland. This chapter represents various types of use and non-use values of wetland and also discusses the direct and indirect use values that are selected for the study.

4.2 Use and Non-Use Benefits of Wetland

Wetland direct use values/benefits are those which can be consumed directly from wetland such as food, water supply, recreation, transport, timber etc whereas indirect uses benefited people indirectly and arises from the functions occurring within the ecosystem, such as water quality, flood control, ground water recharge and other such functions (Ramachandra et al., 2005).

Adapting form Barbier et al. (1997), the components of total economic value of wetlands are described below:

(a) Direct use value

The values which derived from direct use or interaction with wetland resources and services are called direct use value or direct use benefit. Direct uses of wetlands involve both commercial (marketed value) such as agriculture, fisheries, forestry, transport etc and non-commercial activities such as recreation. In general, the value of marketed products is easier to measure compared to non-commercial direct uses.

(b) Indirect Use Value

The indirect support and protection provided by wetland's natural functions or regulatory ecological services of wetlands to economic activity and property are termed as indirect use value. The indirect use value of wetland is related to the change in the value of production and consumption of the activity and property it protects or supports. These values are unmarketed, go financially unrewarded and are only indirectly connected to economic activities. That is why indirect use values are difficult to quantify and are generally ignored in wetland management decisions. Indirect use values of wetlands are flood control, storm protection, ground water recharge etc.

(c) Option Value

A special category of value is option value, which arises when an individual may be uncertain about his or her future demand for a resource and/or its availability in the wetland in the future.

(d) Quasi-Option Value

If an individual is uncertain about the future value of a wetland, but believes that it may be high or the current exploitation and conversion may be irreversible, then it is called quasi-option value. It is simply the expected value of the information derived from delaying exploitation and conversion of the wetland today.

(e) Existence Value

There are individuals who do not currently make use of wetlands but wish to see them preserved in their own right is referred to as existence value. Existence values reflect spiritual, moral and ethical values associated with wetland preservation. It is a form of non-use value that is extremely difficult to measure as it involves subjective valuations by individuals unrelated to either their own or others' use, whether current or future.

(f) Bequest Value

It is an important subset of non-use or preservation value, which results from placing a high value on the conservation of wetlands by individuals for their future generations to use. Bequest values may be particularly high among the local populations who are currently using a wetland, because they would like to see the wetland and their way of life that has evolved in conjunction with it passed on to their heirs and future generations in general.

The following Table 4.1 lists various use and non-use values of wetlands:

Table 4.1: Classification of Total Economic Value of Wetland

<table>
<tr><th colspan="3">Use Values/Benefits</th><th colspan="2">Non-Use Values/Benefits</th></tr>
<tr><th>Direct Use Values</th><th>Indirect Use Values</th><th>Option and Quasi-Option Values</th><th>Existence Values</th><th>Bequest Values</th></tr>
<tr><td>Commercial activities
• Agriculture
• Fisheries
• Fuel-wood
• Transport
• Grains
• Peat/energy
• Forestry
• Wildlife harvesting</td><td rowspan="2">• Nutrient Retention
• Flood Control
• Storm Protection
• Ground Water Recharge
• External Ecosystem Support
• Micro-Climatic Stabilization
• Shoreline Stabilization
• Water Filtration
• Erosion Control</td><td rowspan="2">• Potential future uses (as per direct and indirect uses)
• Future value of information</td><td colspan="2" rowspan="2">• Biodiversity
• Culture
• Heritage</td></tr>
<tr><td>Non-commercial activities:
Recreation
• Boating
• Fauna (birds)
• Wildlife
• Walking
• Viewing
• Fishing</td></tr>
</table>

Source: Adapted and modified from Barbier et al. (1997)

4.3 Use Benefits of the Site

In total valuation approach, as the goal is to estimate the total economic contribution of the wetland, a researcher should at the very least choose those characteristics of wetland to assess that contribute most to its total value and if possible attempt to estimate all the major values (Barbier et al., 1997).

The study is confined with all major direct and indirect use benefits of the site. As direct use benefits, agriculture, fisheries and recreation uses are selected and as indirect use benefits, ground water recharge and flood control functions are selected for the study. Earlier it is mentioned that non-use values of wetland are not included in the study for both time and resource constraints.

4.3.1 Direct Use Benefits

Direct use benefits are selected by conducting a reconnaissance survey in the study area both in dry and wet seasons. It is known that wetland is a very good media for water transport, but in the study area all the boating that are visible are only for recreational purpose not for transporting people or goods from one place to another. That is why transport is not selected as direct use benefits in the study. Direct use benefits of the site are briefly discussed below:

4.3.1.1 Agriculture

In the study area, people only cultivate 'IRRI' (International Rice Research Institute) paddy in dry season, from the starting of November to late of April (Field Survey, 2011). That means they cultivate paddy during six months in a year. They do not cultivate other crops or vegetables at that period. The owner of the land employs farmers and agricultural laborer in the whole process of cultivation. They sow the seeds at the starting of November and start cutting paddy at the late of April. The whole process of cultivation is described in Chapter 5.

Production of paddy on the wetland

After cutting, paddy are carried out

Paddy are prepared to transport

Paddy are transporting to harvesting ground

Harvesting ground

Owner is selling paddy to wholesalers

Source: Field Survey, 2011

Figure 4.1: Cultivation of Paddy in the Site during Dry Season

4.3.1.2 Fisheries

Wetland is the natural breeding ground of a large number of fish during rainy season (Haq et al., 2005). It is previously mentioned that people cultivate crops during six months in a year. They also cultivate fishes in the remaining six months, that means in the monsoon, from the starting of May to the late of October. They cultivate fishes two times within these six months (Field Survey, 2011). The owner of the land employs the fish farmers, fishermen, watchmen in the whole production process. They mainly cultivate large fishes such as Ruhit, Silver cup, Brigate etc. They mainly sell these fishes to the local market. Sometimes when fishes are caught at a small scale then those are sold to the customers at the places along the streets near the site.

Fishermen are catching fishes

Owner is selling fishes along the road

Source: Field Survey, 2011

Figure 4.2: Fishing in the Site during Monsoon

4.3.1.3 Recreation

Recreational areas refer to the places with its surroundings, facilities and amenities that allow people to conduct recreational activities for their enjoyment (Azyyati et al., 2007). Wetlands are often used as attractive recreational site specially during monsoon. As the site is turned into vast water body in monsoon, at that period it becomes a place of attraction for the city dwellers. The visitors mostly enjoy the scenic beauty of the site when it is full of water. There are many floating restaurants

at that place. People sit and gossip there, take food from the restaurants and enjoy the scenic beauty. There are entry fee for the visitors to get into the restaurants. Boating facility is also provided in that place which the visitors enjoy a lot. They can go to a far distant place by boating and can enjoy the scenery of a rural setting as there are many rural homesteads outside the site. Thus, the site offers the city dwellers the beauty and serenity of the countryside.

Floating recreational spaces over the wetland

Scenic beauty of the site from the floating spaces

Connection of the floating spaces with the road

Boating facilities as a part of recreation on the wetland

Source: Field Survey, 2011

Figure 4.3: Recreational Facilities in the Site during Monsoon

4.3.2 Indirect Use Benefits

Indirect use benefits of the site are identified by reviewing literature like books, journal articles etc. Due to the limitation of time, the study is only confined with those two important indirect functions of wetland that are selected.

4.3.2.1 Flood control function

Monsoon rainfall and the spillage from the adjacent rivers are the main causes of flooding in Dhaka city. The site is the active flood plain of its adjacent Turag river. It remains under water for about six months of the year from May to October. The site accumulates flood water from surrounding areas and conveys it slowly from upland to downstream points. The combined water storage and braking action lowers flood heights and thus protect infrastructure, housing and property from severe flood damage.

4.3.2.2 Ground water recharge function

Aquifers are recharged with water through precipitation that seeps into the ground. Wetlands are treated as important areas for ground water exchange as they retain water and provide time for infiltration. The site is also an important area for ground water recharge as it retains huge amount of water during monsoon. This area facilitates to infiltrate water from surface to underground during this period. Thus, in the city like Dhaka where acute water crisis exists, this area acts as an important recharge area for ground water. Ground water is treated as a pure source of water which is used for drinking, irrigation and other such purposes.

Source: Field Survey, 2011

Figure 4.4: The Site Retains Huge Amount of Water during Monsoon

Chapter 5: Valuation of Agricultural Products

5.1 Introduction

Agriculture is one of the most important direct use benefits of wetland. In the study area during dry season from the starting of the month November to late of April (Field survey, 2011) people only cultivate paddy on the wetland. The owners of the land employed farmers and laborers in the rice production process. In the study along with other direct uses of wetland agriculture is selected to assess the yearly benefit incurred from it and the process of valuation is described in this chapter.

5.2 Method Used for Valuation

Applying valuation technique requires an understanding of the economic concept of 'willingness to pay', which is the basis for economic valuation of any good or service. In a competitive economy, with no distortions to the price mechanism, one can assume that market prices reflect the willingness to pay for goods and services. For those direct use values which primarily involve harvesting of wetland resources, prevailing market prices serve adequately as measures of value (Barbier et al., 1997).

The best approximation of the 'true value' of a good or service that is fairly and widely bought and sold is its market price, the price that a person is willing to pay to gain the satisfaction of consuming the item (Gittinger, 1984). The fundamental basis of value for agricultural properties is 'market value' and the foundation for the valuation must be market derived (IVSC, 2002). That is why in the study the economic value of agricultural product is derived from 'Market Price Method'. In this method the prevailing prices for goods and services traded in domestic markets are used for quantifying wetland resources.

5.3 Data Collection Procedure

The first step in valuing costs and benefits, is finding the market prices for the inputs and outputs are often a difficult task. Required data for the valuation of agricultural inputs and outputs have been collected through 'Focus Group Discussion' of

Participatory Rural Appraisal (PRA) method. Before collecting data a checklist has been prepared containing all the variables on which data have to be collected. A reconnaissance survey was conducted in the late of April, 2011 since the farmers and the owners of the land were busy with cutting and harvesting paddy.

A group discussion has been arranged on a pre-scheduled date. That means the participants of the group discussion were informed earlier about the issue, the place and date of discussion. The group consists of 10 local people including farmers, land owners, wholesalers and retailers of agricultural crops. The selection of these people was made on the basis of their detailed knowledge on the concerning issue. There was an effort to form this group with the combination of all stakeholders regarding agriculture production.

At first the purpose of the discussion has been explained briefly to them. Then the questions are placed one by one before them following the checklist. Any differences in providing economic data and information are resolved by discussion and by arriving at a consensus. The discussions are seen as important instruments for generating insights. There is no rush in asking questions to them.

The whole process of rice production has been briefly explained by the participants. At the initial stage of the production a hired laborer operating a hand tractor starts plowing to prepare the land for sowing the seeds. Most other activities, like seedbed preparation (including planting), crop care (weeding, fertilizer and chemical application) are usually done with family labor. They sow the seeds of paddy in dry season particularly at the starting of the November. Then they put different types of fertilizers, insecticides on the land. Fertilizers like urea, potassium, phosphates etc are used to increase the fertility of land and insecticides are used to kill the insects and weeds.

One of the most important requirements in the rice production process is to ensure irrigation. They told that the process of irrigation needs to be continued from the planting of seeds up to the cutting of paddy. The day laborers start cutting the paddy in the late of April. After cutting they are transported to the nearest place of harvesting. Then the harvested paddy is sold to the wholesaler. The wholesaler then

transports the product from the harvesting field to the stocking and husking ground. The wholesaler husks the paddy by laborer. Finally, the processed product (rice) is sold to the retailers of the local market.

After completing the entire discussion the participants are thanked to give their valuable time and information. Then the local government institution named as Union Parishad Office and the local markets (Ashulia bazaar, Mirpur-1 no. bazaar) where agricultural inputs and outputs are transacted are also visited to cross check the data collected from focus group discussion and to obtain all other economic data and information necessary for the valuation of agricultural crops. In this way the prevailing price for each input and output are obtained in the study.

5.4 Data Analysis

By analyzing data it has been found that there are four groups of participants in the marketing process of the product- producer, wholesaler (processor), retailer and the customer.

Producer: Who own the land, cultivate paddy by the farmers on their land and spend money in all stages for the production of paddy.

Wholesaler: Who own large stocking ground, buy products from the owner of the land, transport products from farm gates to the husking ground, process the product and convert paddy to rice and finally sell them to the retailers.

Retailer: Who buy the products from wholesalers and sell directly to ultimate consumer at the market places.

Customer: Who buy the product from the retailers at market price directly from the market.

The value of the benefit is determined by its price, i.e. the amount of money for which it will be exchanged (Ramachandra et al., 2005). The price that the owner receives from the wholesaler varies from the final marketing price. The increased value added of the product as it is processed and delivered to a market arises from

the labor and capital engaged in the marketing service, not properly attributed to the investment to produce the commodity (Gittinger, 1984). As the price of the product varies in every stages of the marketing process it is a question of which price would be applied for the valuation of the product.

A good rule for determining a market price for agricultural commodities produced is the price at the 'point of first sale' or 'farm-gate' price- the price that the owner of the land receives when he sells his product. If the point of first sale is in a relatively competitive market, then the price at which the commodity is sold in this market is a relatively good estimate of its value in economic as well as financial terms (Gittinger, 1984). As the overall situation of the study area meets the above mentioned criteria, the farm-gate price here is used for the valuation of paddy and local market price is used for the valuation of rice (final processed product).

Finally, the economic analysis of rice production from wetland is placed in the appropriate appraisal framework. A cost-benefit analysis has been conducted which normally involves calculating on an annual basis the benefits and costs of conserving the natural wetland functions, products and attributes over a selected time period (Nhuan, 2003). The three most common methods for comparing costs and benefits i.e. net present value, internal rate of return and benefit-cost ratio have been calculated here. **The economic worth of agricultural products are estimated and analyzed by the following steps:**

Step 1: Valuation of Agricultural Inputs

Through Focus Group Discussion major cost heads in rice production, per hectare quantity required for those components and their respective market prices are collected. Then all those market prices under each cost head are summing up to derive the total cost of production of rice per hectare. All the inputs required for rice production and their market prices are given in the following Table 5.1:

Table 5.1: Total Cost of Rice Production (per hectare)

Cost Head		Quantity per Hectare	Cost per Hectare (Tk)
Plowing land		1man 7 days labor	5,000
Seeds		75 kg	1,312
Fertilizer	Phosphate	93 kg	2,000
	Urea	93 kg	1,000
	Potassium	93 kg	1,400
Pesticides		1.86 kg	300
Irrigation		14hrs per week (16 weeks)	44,800
Cutting of paddy		35 man 7 days labor	15,750
Transportation cost (agricultural land to harvesting ground)		4 days any number of trips by boat	3,500
Harvesting		5579.07 kg paddy	11,000
Transportation cost (harvesting ground to husking place and local market)		1 day any number of trips by truck	1,300
Husking		5579.07 kg paddy	5,500
Total Cost per Hectare (Tk)			**92,862**

Source: Field Survey, April, 2011

Step 2: Valuation of Agricultural Outputs

In the process of selling the production, the wholesaler buy paddy from the owner of the land at Tk 21 per kg. Then they carry the product to the husking ground and after husking they transport rice to the local market and sell the products to the retailers of the local market at Tk 26 per kg. The retailers then sell that rice to the customers at higher price, Tk 30 per kg. The owners of the land informed that around 5.58 MT of paddy can be yielded from one hectare of land (Field survey, 2011). The marketing price of rice and paddy are shown in the following Table 5.2:

Table 5.2: Marketing Price of Paddy and Rice (per hectare)

Benefit Head	Per Unit Selling Price (Tk/MT)	Per Hectare Production (MT)	Total Price per Hectare (Tk)
Owner of the land	21,000	5.58	117,160
Wholesaler	26,000		145,056
Retailer	30,000		167,372

Source: Field Survey, April, 2011

Some economic indicators are also analyzed in the study such as marketing cost, marketing margin and profit margin of the product. Marketing cost of the product refers to the costs incurred from the point of production up to the point of distribution for final consumer. Marketing margin of product is the difference between the price paid by ultimate consumers and that obtained by producers (Son et al., 2003) which can be written simply as:

Marketing margin = Selling price – Buying price

Total profit margins = Gross marketing margin – Total marketing costs

Table 5.3: Operating Efficiency of Actors along the Marketing Channels of Rice

Actors of marketing channel	**Buying price (Tk)**	**Selling price (Tk)**	**Marketing margin (Tk)**	**Marketing cost (Tk)**	**Profit margin (Tk)**
Wholesaler	117,160	145,056	27,895	6,800	21,095
Retailer	145,056	167,372	22,316	0	22,316
Total			50,212	6,800	43,412
Distributed proportion to the wholesalers (%)			55.56	100	48.59
Distributed proportion to the retailers (%)			44.44	0	51.41

Source: Field Survey, April, 2011

Step 3: Cost-Benefit Analysis of the Production

In assessing the net benefit from the production of paddy it is assumed that all the outputs are marketed, nothing is consumed by the owners of the land or the farmers. Because the aim of this cost benefit analysis is to calculate the net benefit that can be earned by an owner from the wetland in a year if it is properly conserved by cultivating paddy in dry season.

In the study area people cultivate paddy during six months in a year (From early November to end of April). All the cost and benefit related data are collected in the late of April, 2011. Within these six months costs are spent in different phases, starting from November, 2010 to the late of April, 2011 whereas all the benefits are incurred in the late of April, 2011. For the easement of the calculation it is assumed that all the costs in production were invested in the early November of the year 2010.

So in the cost benefit analysis of the production of paddy the year 2010 is assumed as the base year.

(a) Total cost of the production of paddy

Excluding the transport cost (from harvesting ground to husking field) and cost of husking from the total cost of production of rice, total cost of production of paddy incurred by the owner of the land is obtained and it is Tk 86,062 per hectare (Field survey, 2011).

(b) Total benefit from the production of paddy

As it is previously mentioned that around 5.58 MT or 5579 Kg paddy have been yielded from one hectare of agricultural land and an owner of the land has earned Tk 21 per Kg by selling paddy to the wholesaler. The owner of the land has also earned Tk 5,000 by selling straw produced in one hectare of land (Field survey, 2011).

Thus, the total benefit of the owner per hectare is $= Tk\ (21 \times 5579 + 5000)$

$$= Tk\ 122{,}160$$

(c) Net Present Value (per hectare):

As the starting of November in the year 2010 is assumed as the base year for calculation and benefits are incurred after six months that means at the end of the month April in 2011, so this benefit is 'Future Value Benefit' and the 'Present Value Benefit' can be derived by the following formula:

$$PVB = \frac{FVB}{(1+r)^n}$$

$$= \frac{122{,}160}{(1+0.1)^{0.5}}$$

$$= Tk\ 116{,}475$$

Here discounting rate is taken as 10%, because at present the interest rate on fixed deposit account in government banks of Bangladesh is 10% in a year (It is known

from a formal conversation with a banker of Sonali Bank). As benefit from the production of paddy comes after six months from the investment so the life of the production cycle here is six months or half year.

NPV = PVB – Initial Investment

$= Tk\ (116{,}475 - 86{,}062)$

$= Tk\ 30{,}413$

NPV > 0 so, the production of paddy in the wetland is beneficial for the owner of the land. From the calculation it can be figure out that the net benefit of the owner of the wetland from the production of paddy in the year 2010 is **Tk 30,413 per hectare**.

(d) Benefit Cost Ratio (B/C ratio)

Benefit Cost Ratio: $BCR = \frac{PVB}{I}$

$$= \frac{116{,}475}{86{,}062}$$

$$= 1.35 > 1$$

Net Benefit Cost Ratio: $NBCR = BCR - 1$

$$= 1.35 - 1$$

$$= 0.35 > 0$$

Benefit cost ratio and net benefit cost ratio also prove that it is benefited for the owner of the land to produce paddy in dry season in wetland.

(e) Internal Rate of Return (IRR)

The internal rate of return is the rate at which the return would be earned on the initial investment. Despite NPV's conceptual superiority, some people prefer IRR over NPV because IRR is intuitively more appealing as it is a percentage measure

(Chandra, 2004-05). But there are some shortcomings of the regular IRR which can be customized by calculating Modified Internal Rate of Return (MIRR). The procedure for calculating MIRR is as follows:

At first the benefit which is earned after six months of the initial investment is converted to its future value after six months at 10% interest rate by the following formula-

$$FVB = PVB \times (1 + r)^n$$

$$= 122{,}160 \times (1 + 0.10)^{0.5}$$

$$= Tk\ 128{,}123$$

MIRR is obtained by solving the following equation-

$$Initial\ Investment = \frac{Cash\ flow\ at\ the\ end\ of\ the\ year}{(1+MIRR)^n}$$

$$86{,}062 = \frac{128{,}123}{(1+MIRR)^1}$$

So, MIRR = 48.9%

It means that benefit is earned at the rate of **48.9%** on initial investment in one hectare of land for the production of paddy in the year 2010.

5.5 Conclusion

Market prices may be distorted by deliberate interventions or imperfect competition, such as the existence of exchange rate controls, price ceiling or supports, subsidies or taxes, monopoly conditions etc (Barbier et al., 1997). Due to the limitation of time and resources and due to the intention of covering so many functions of wetland and their valuation methods in the study, here in valuing agricultural products, market imperfections, shadow pricing, policy failures and seasonal variations which may distort market prices are not considered. It is assumed that perfect market condition exists throughout the year. Prices in international markets are also not considered in the study.

Chapter 6: Valuation of Fisheries

6.1 Introduction

As flood flow zones are seasonally flooded, in the study area people are engaged with fishing during monsoon that means from the starting of May to the end of October. They cultivate fishes two times within these six months (Field survey, 2011). In the study fish farming (fish capture and fish culture) is selected to assess its economic worth in a year as the local people in the study area are engaged in fishing to a large extent in wet season. The economic worth of fishing is discussed in this chapter.

6.2 Method Used for Valuation

According to the early discussion in agricultural production section, as fisheries have marketed values, the economic benefits from fish farming can be derived from 'Market Price Method'. In this method the prevailing market prices of fishes, traded in domestic markets are used for its valuation.

6.3 Data Collection Procedure

Required data for the valuation of fishing have been collected by applying the same technique as in agriculture that means through 'Focus Group Discussion' of Participatory Rural Appraisal (PRA) method. Before collecting data a checklist has been prepared containing all the variables related to the valuation of fish farming. During July, 2011 a reconnaissance survey was carried out while the fishermen were busy to catch fishes and land owners were in a hurry to sell and distribute those fishes.

A group discussion has been arranged on a pre-scheduled date. That means the participants of the group discussion were informed earlier about the issue, the place and date of discussion. The group consists of 10 local people including fish farmers, fishermen, land owners, wholesalers and retailers of fisheries. The selection of these

people was made on the basis of their detailed knowledge on the concerning issue. There was a combination of all stakeholders engaged in fish production and selling.

At first the purpose of the discussion has been explained in brief to the participants. Then the questions are placed sequentially before them according to the checklist. Any differences in providing economic data and information are resolved by discussion and by arriving at a consensus.

The participants of the group discussion have explained briefly the process of fish farming. The owner of the land employs the fish farmers, fishermen, watchmen in the whole production process. At the first stage they spread different types of fish seeds, mainly Ruhit, Silver cup, Brigate and such other fish seeds throughout the water during monsoon specially at the starting of May and September. The fish farmers told that summer is the favorable season for the fish seeds for their early growth.

After that they provide food (husk) for the growth of fishes. They also throw potassium and lime in the water at the early stage of fish rearing. Potassium is used so that the fishes cannot be infected and lime is used to make the water clean and clear so that algae cannot form in water. The owners of the lands informed that they have to provide ‘Gher’ (artificial enclosure) in the rainy season so that the fishes cannot run away to the nearest river.

They also told that it requires three to four months to form a large size fish after the deposition of its seed. After the growth of juvenile fish to a large one the fishermen start catching fish throughout the wet season in one month gap. After catching fishes these are transported by the owner of the land to sell them to the wholesalers who further sell those fishes to the retailers of the local market at higher prices.

After completing the discussion they are thanked to share their valuable time and ideas. Then the local markets (Ashulia bazaar, Mirpur-1 no. bazaar) where fishes that are captured in the study area are marketed are also visited to obtain all economic data and information necessary for the valuation of fishing.

6.4 Data Analysis

By analyzing data of fisheries it has been found that like agriculture there are also four groups of participants in the marketing process of fishes- producer, wholesaler, retailer and the customer.

Producer: Who own the land and spend money in all stages for the production of fishes.

Wholesaler: Who own large stocking facilities, buy fishes from the owner of the land and finally sell them to the retailers.

Retailer: Who buy fishes from wholesaler and sell directly to ultimate consumer at the market places.

Customer: Who buy fishes from the retailers at market price directly from the market.

Due to the reasons mentioned earlier in the agricultural product valuation section, farm-gate price is used for the valuation of fishes. Some economic indicators are also analyzed in the study such as marketing cost, marketing margin and profit margin of the product (fishes).

Finally, the economic analysis of fish production from wetland is placed in the appropriate appraisal framework. A cost-benefit analysis has been conducted that means net present value, internal rate of return and benefit-cost ratio of fish production have been calculated here.

The economic worth of fishes are estimated and analyzed by the following steps:

Step 1: Valuation of Inputs of Fish Production

Through Focus Group Discussion major cost heads in fish production, per hectare quantity required for those components and their respective market prices are collected. Then all those market prices under each cost head are summing up to derive the total cost of production of fishes per hectare. All the inputs required for fish production and their market prices are given in the following Table 6.1:

Table 6.1: Total Cost of Production of Fishes (per hectare)

Cost Head	Quantity per Hectare	Cost per Hectare (Tk)
Fish seed	279 kg	30,000
Fish feed (Husk)	56 kg	11,000
Potassium	1.5 kg	500
Lime	28 kg	1,000
Watchman	1 man 3 months labor	10,000
Gher (Artificial enclosure)	-----	5,000
Labor (Catching of fishes)	6 labor per catching	10,000
Transportation cost (From the location of catching fish to wholesale market)	7 trips by van	2,000
Total Cost per Hectare (Tk)		**69,500**

Source: Field Survey, July, 2011

Step 2: Valuation of Outputs (Fishes)

In the process of fish production, the owner transports the fishes to the wholesale market by van and sells fishes to the wholesaler at Tk 70 per kg. The wholesaler then sells the product to the retailers of the local market at Tk 100 per kg. The retailers carry the fishes to the local market by auto-rickshaw and sell the products to the customers at higher price, Tk 140 per kg. The owners of the land informed that around 2.5 MT of fishes can be yielded from one hectare of land (Field survey, 2011). The marketing prices of fishes are shown in the following Table 6.2:

Table 6.2: Marketing Price of Fishes (per hectare)

Benefit Head	Per Unit Selling Price (Tk/MT)	Per Hectare Production (MT)	Total Price per Hectare (Tk)
Owner of the land	70,000	2.5	175,000
Wholesaler	100,000		250,000
Retailer	140,000		350,000

Source: Field Survey, July, 2011

The marketing margin and total profit margin in the marketing channels of fishes are given in the following Table 6.3:

Table 6.3: Operating Efficiency of Actors along Marketing Channels of Fishes

Actors of marketing channel	Buying price (Tk)	Selling price (Tk)	Marketing margin (Tk)	Marketing cost (Tk)	Profit margin (Tk)
Wholesaler	175,000	250,000	75,000	0	75,000
Retailer	250,000	350,000	100,000	11,100	88,900
Total			175,000	11,100	163,900
Distributed proportion to the wholesaler (%)			42.86	0	45.76
Distributed proportion to the retailer (%)			57.14	100	54.24

Source: Field Survey, July, 2011

Step 3: Cost-Benefit Analysis of the Production

In assessing the net benefit from the production of fishes it is assumed that all the outputs are marketed, nothing is consumed by the owners of the land or the farmers. Because the aim of this cost benefit analysis is to calculate the net benefit that can be earned by an owner from the wetland in a year if it is properly conserved by utilizing land for the production of fishes in wet season.

As earlier it is mentioned that people farm fishes two times in a year (From early May to end of October). All the cost and benefit related data are collected in the late of July, 2011. Within three months costs are spent in different phases, starting from May, 2011 to the late of July, 2011 whereas all the benefits are incurred in the late of July, 2011. For the easement of the calculation it is assumed that all the costs in production were invested in the early May of the year 2011. As the year 2010 is selected as the base year for the cost benefit analysis of rice production, here this year is also assumed as the base year for calculation. In such case it will be easier to determine the total benefit derived from rice production and total benefit incurred from fish production in the same year that means in 2010.

(a) Total cost of the production of fishes:

Total cost incurred by the owner of the land for the production of fishes in three months is Tk 69500 per hectare (Field survey, 2011).

(b) Total benefit from the production of fishes:

As it is previously mentioned that around 2.5 MT or 2500 Kg fishes have been yielded from one hectare of wetland and an owner of the land has earned Tk 70 per Kg by selling fishes to the wholesaler (Field survey, 2011)

Thus, the total benefit of the owner per hectare is $= Tk\ (70 \times 2500)$

$$= Tk\ 175{,}000$$

(c) Net Present Value (per hectare):

People invest money two times in a year for fishing. As the starting of November, 2010 is assumed as the base year for calculation, all the cost and benefit related data are calculated on the basis of that year.

It is assumed that if a person has made all the investments in fishing in the starting of May, 2011 and all his benefits are incurred in November, 2011, then the net present value (*NPV*) in November, 2010 for this investment can be derived by the following formula:

$$PVB = \frac{FVB}{(1+r)^n}$$

$$= \frac{350{,}000}{(1+0.1)^1}$$

$$= Tk\ 318{,}182$$

$$PVC = \frac{FVC}{(1+r)^n}$$

$$= \frac{139{,}000}{(1+0.1)^{0.5}}$$

$$= Tk\ 132{,}531$$

$$NPV = PVB - PVC$$

$$= Tk\ (318{,}182 - 132{,}531)$$

$$= Tk\ 185{,}651$$

Here discounting rate is taken as 10%, because at present the interest rate on fixed deposit account in government banks of Bangladesh is 10% in a year.

The calculate *NPV* is greater than zero. So, the production of fishes in the wetland is beneficial for the owner of the land. From the calculation it can be figure out that the net benefit of the owner of the wetland from the production of fishes in the year 2010 is **Tk 185,651 per hectare.**

(d) Benefit Cost Ratio (B/C ratio)

Benefit Cost Ratio: $BCR = \frac{PVB}{PVC}$

$$= \frac{318{,}182}{132{,}531}$$

$$= 2.40 > 1$$

Net Benefit Cost Ratio: $NBCR = BCR - 1$

$$= 2.40 - 1$$

$$= 1.40 > 0$$

Benefit cost ratio and net benefit cost ratio also prove that it is benefited for the owner of the land to farm fishes in wet season in wetland.

(e) Internal Rate of Return (IRR)

Due to the same reason mentioned in agriculture section, modified internal rate of return (MIRR) is calculated instead of internal rate of return. The steps for calculating MIRR is as follows:

$$PVC = \frac{FVC}{(1+r)^n}$$

$$= \frac{139{,}000}{(1+0.1)^{0.5}}$$

$$= Tk\ 132{,}531$$

MIRR is obtained by solving the following equation-

$$Investment = \frac{Cash\ flow\ at\ the\ end\ of\ the\ year}{(1+MIRR)^n}$$

$$132{,}531 = \frac{350{,}000}{(1+MIRR)^1}$$

So, MIRR = 164%

It means that benefit is earned two times at the rate of **164%** on investment in one hectare of land for the production of fishes in the year 2010.

6.5 Conclusion

Due to the limitation of time and resources in assessing the economic worth of fisheries by market price method, market imperfections, shadow pricing, policy failures and seasonal variations which may distort market prices are not considered. It is assumed that perfect market condition exists throughout the year.

In this analysis average cost of fishing and average local market price of fishes are used disregarding the species differentials that may under estimate the potential benefits of fish resources. Prices in international markets are also not considered in the study.

Chapter 7: Valuation of Recreational Site

7.1 Introduction

The demand for outdoor recreation is growing day by day as a consequence of increasing population, income and holiday entitlement (Garrod and Willis, 2001). Wetlands are often used as attractive natural recreational sites which are non-priced and have open access. Since access to such natural recreational areas is often only subject to nominal entry fees or in some cases without any fees that clearly underestimate the maximum willingness to pay by most visitors (Joe et al., 2008). That is why understanding the recreational value of natural resources is important to take effective decisions in national conservation programs. In this chapter the recreational value of the site is discussed in detail.

7.2 Method Used for Valuation

Wetlands have significant recreational value. Such type of intangible benefits are not properly assessed or incorporated in development projects or national budget allocation process specially in developing countries. The significant problem behind such disregard is that the scenic beauty of wetlands is not exchanged and priced in market. The non-market goods cannot be evaluated as the same way as the market goods by analyzing the observed quantities and prices in the market. For this reason people think that these public goods have little value or they are irrelevant to the market value, so its recreational value could be ignored or even lost (Tang, 2009). But the values of non-market goods and services need to be measured and expressed in monetary terms so that they can be weighted on the same scale as commercially traded components (Elliot et al, 2001 cited in Azyyati et al., 2007).

Travel cost method (TCM) is used by the economists to estimate the values produced by environmental systems that serve as outdoor recreation site (Ward, 2006). The advantage with using this method is that it is based on real behavior of people and here conclusions can be drawn from a relatively small sample (Garrod and Willis, 2001). It is a non-market approach whereby a recreational site is evaluated by considering how much people are willing to spend to reach the site. That means, the

costs spent by a person for the consumption of the recreational amenity of a particular site are used as a proxy for its price. These costs include travel costs to and from the site, time cost, entry fees, on-site expenditures (Fleming and Cook, 2007).

TCM is a demand based model for use of a recreation site by which peoples' willingness to pay to visit the site can be estimated based on the number of trips they make at different travel costs. Among three types of travel cost methods, individual travel cost method (ITCM) is selected in this study to evaluate the recreational benefit of the site. This method makes its estimation by using each individuals travel cost (Bulov and Lundgren, 2007).

7.3 Data Collection Procedure

Required data for the valuation of recreational site are collected by the following steps:

7.3.1 Questionnaire Design

To fulfill the objectives of the study a questionnaire (Appendix 1) is designed covering all the variables required for the analysis. The questionnaire consists of 10 questions. The first section includes variables regarding the socio-economic characteristics of the visitors such as age, gender, educational qualification, occupation, individual income, expenditure on recreation etc. The following questions are on their site visit related issues like frequency of visit in the site, group size, number of visits in the last year (2010), preferable season, day and time to visit the site. In the last section of the questionnaire all travel and on-site cost related questions are incorporated such as travel time, mode of transport to the site, on-site time, travel cost, food cost, boating cost, parking cost, entry fee. Finally, the visitors are asked about the attractive features of the site, the availability of substitute sites and whether there are any multi-destination trips (MDT) or not.

Demand theory assumes that the demand for a good is related to the prices and availability of substitutes as well as its own price and other factors (Caulkins et al., 1986). Therefore, the issue of substitutes needs to be solved in the demand analysis

of the environmental goods. A question where the visitors are asked to state about substitute site is incorporated in the questionnaire to address this problem.

A pilot survey has been conducted to verify the accuracy of the questionnaire in the practical situation that means to check if there any need to include or modify or to omit any variable. This survey also checked whether the respondents feel free to answer the questions or not. The survey has been carried out for two days (Friday and Saturday) collecting 5 samples in each day.

7.3.2 Sampling Strategy for the Survey

Determining the sample size is a crucial issue for the accuracy of travel cost model. No specific study has been carried out to address the ideal sample size for travel cost method (Ahmad, 2009 cited in Rahman et al., 2011). By reviewing some recent researches (Tang, 2009; Azyyati et al., 2007; and Bulov and Lundgren, 2007) it is found that, the researchers do not work with any fixed or specific sample size and usually conduct survey throughout a year or during the weekends of a month or even for a week.

The data are collected during the weekends (Friday and Saturday) from 3 pm to 7 pm in July, 2011. On an average the total number of visitors visiting the site over the weekends in a month is 2800 (Field survey, 2011). At 95% confidence interval the required sample size for this population is 338. In the study, considering the possibility of errors regarding survey data total 350 visitors are surveyed.

A face to face interview has been conducted so that there is no possibility of missing of data from the questionnaire and therefore the completeness of data can be ensured. Each single sample has been selected randomly. The random individual is the first one seen after completing the previous interview. Each interview required 15 to 20 minutes to complete.

7.3.3 Questionnaire Survey Strategy

(a) Before collecting data the purpose of the study has been clearly explained to the respondents and it is ensured that there is no record of their name or address and their personal information will be kept confidential.

(b) The visitors may visit the site for purposes other than recreation. To avoid such problems of multi-purposes visit, visitors are at first asked about their sole purpose of visiting the site and if it is only for recreation then those visitors are interviewed.

(c) For the visitors who travel a long distance to visit the site, their entire trip may have many destinations. This problem is known as multiple destination trips and in such case assigning the entire travel cost to the specific site would cause an overestimation of the targeted site's recreational value (Garrod and Wills, 1999). To solve this multiple destination trips (MDT) problem Loomis and Walsh (1997) presented two alternatives. One of them is to ignore MDT and include only the related trip costs in the demand analysis. In the study in cases of MDT, the particular trip cost for visiting the study area is collected.

(d) To avoid the complexity regarding the data of overseas visitors an option may be to omit all overseas visitors from the sample (Fleming and Cook, 2007). In the study the overseas visitors are not interviewed.

(e) Any sample of visitors to a recreational site is selective and cannot represent those people who choose not to visit the site. In an on-site sample, the observed visit rate to a site in a year starts at one visit per year and excludes values that are less than one (Garrod and Willis, 2001). In the study in on-site survey the sample is truncated in that only those individuals who make one or more visits are observed. This produces a dependent variable which is truncated below one visit.

(f) From analyzing the survey data, it is found that most of the people came to the site in group and in most cases the group size was two (Field survey, 2011). The pilot survey also reveals this fact. For this reason each group member were questioned so that the true male-female share as well as their socio-economic profile can be depicted. The total cost (travel cost, food cost, boating cost, entry fee, parking cost)

incurred by a group of visitors visiting the site is distributed equally to all members of the group assuming that total cost is shared equally by the group members.

(g) Tang (2009) has documented that for those people who come to the site by their own private car, their travel cost should be measured by petrol fee. In the study those who have come to the site by their private car or motorcycle are asked to mention the petrol or CNG (Compressed Natural Gas) cost spent by them as a fuel for their vehicles for coming to the site.

7.4 Data Analysis

Of the 350 samples 310 are finally selected for analysis by excluding those survey forms that are incomplete and containing information of visitors who have zero visits in the year 2010. Data are analyzed by using SPSS 12.0 software.

7.4.1 Profile of the Respondents

7.4.1.1 Socio-economic profiles of the visitors

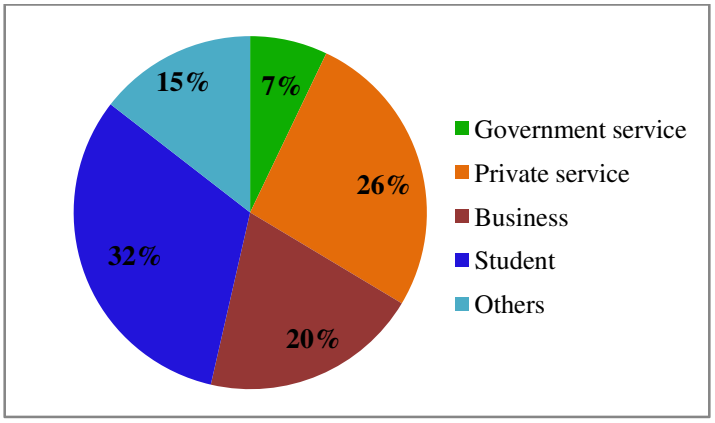
By analyzing the socio-economic characteristics of the visitors it is found that, the ratio between male and female visiting the site is around 3:2 (Table 7.1). Most of the visitors (around 97%) are in group and in most of the cases (47%) the group size consists of 2 members. All female visitors are accompanied by male visitors in a group (Field survey, 2011).

This site is mostly enjoyed by young people and it is revealed from the age distribution of the visitors where a significant share (More than half) falls in the age cohort of 16-25 years (Table 7.1). It is also revealed from the occupation data where students constitute the major portion of the visitors of the site (Figure 7.1).

Table 7.1: Socio-Economic Characteristics of the Visitors

Characteristics	Categories	Percent (%)
Gender	Male	**61.0**
	Female	39.0
Age	16-25	**53.2**
	26-35	35.5
	36-45	9.4
	More than 45	1.9
Educational Qualification	Illiterate	1.0
	Below SSC	11.6
	SSC	11.3
	HSC	**35.2**
	Graduate	26.5
	Post-Graduate	14.5
Occupation	Government service	7.1
	Private service	26.5
	Business	20.0
	Student	**31.9**
	Others	14.5
Monthly Individual Income (Tk)	No income	**31.3**
	Upto 5000	5.5
	5001-15000	27.4
	15001-25000	11.6
	25001-35000	9.7
	35001-50000	9.4
	More than 50000	5.2

Source: Field Survey, July, 2011



Source: Field Survey, July, 2011

Figure 7.1: Distribution of Different Types of Visitors' Occupation

More than one-third (35%) of the total respondents have completed their higher secondary school and among them a significant portion (72%) is now student (Appendix B, Table B1). That means after completing higher secondary school they are engaged in undergraduate studies. Another observation from analyzing data is that most of the (more than 50%) graduate and post graduate visitors are employed in private services (Appendix B, Table B1). Most of the respondents in 'others' occupation category are housewives (Field survey, 2011).

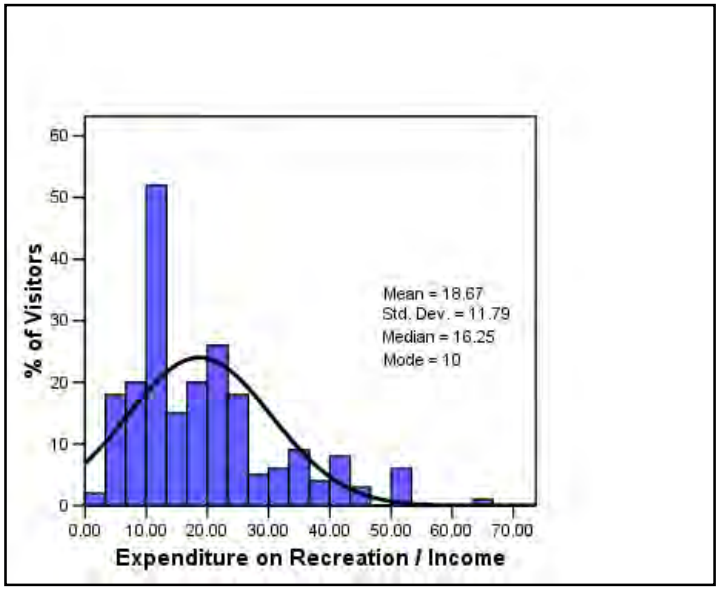
In context of our country students are not the earning members of the family. Usually they either take money from the family or earn money by private tutoring to meet their necessities. Again, the household activities cannot be evaluated in monetary term; they depend on their family to satisfy their need. For these reasons, majority of the visitors has fallen within 'no income' group range (Table 7.2). In case of the students who are engaged in private tutoring, the amount of money that is earned is nominal and it ranges mostly from Tk 1000-5000 which is also revealed from the data. In Table 7.2, it is found that in upto Tk 5000 range students' share is the largest.

Table 7.2: Distribution of Visitors (in percentage) Based on Their Occupation and Monthly Individual Income

Occupation	Monthly Individual Income of the Respondent (Tk)							Total
	No income	Upto 5000	5001-15000	15001-25000	25001-35000	35001-50000	More than 50000	
Government service	0.0	0.0	3.5	2.3	1.0	0.3	0.0	7.1
Private service	0.0	0.6	10.3	5.2	4.2	3.9	2.3	26.5
Business	0.0	1.0	3.5	3.5	4.2	4.8	2.9	20.0
Student	**22.6**	**2.9**	6.5	0.0	0.0	0.0	0.0	31.9
Others	**8.7**	1.0	3.5	0.6	0.3	0.3	0.0	14.5
Total	**31.3**	5.5	27.4	11.6	9.7	9.4	5.2	100.0

Source: Field Survey, July, 2011.

As it can be seen from Table 7.2, the site is visited mostly by students and middle income people. This is implied based on the fact that people from lower income group (monthly income up to Tk 5000) as well as higher income group (monthly income more than 50000) are the least among who visited the site (in both cases, the fraction is around 5%).



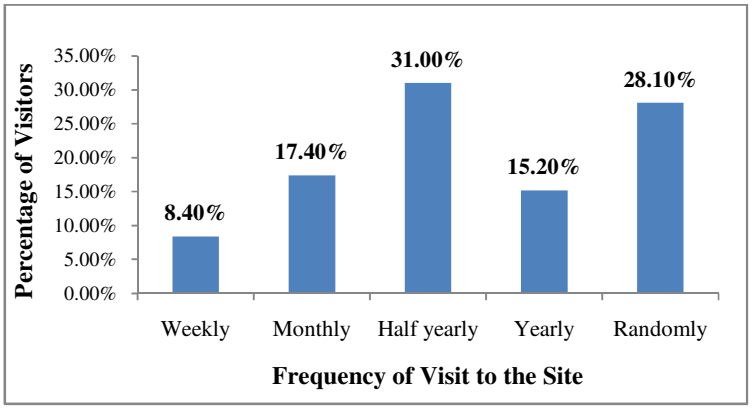
Source: Field Survey, July, 2011.

Figure 7.2: Distribution of Visitors (%) Based on Fraction of Monthly Individual Income Expended on Recreation

It can be implied from Figure 7.2 that, most of the respondents expend 10%-20% of their monthly income for recreation purpose.

7.4.1.2 Travel pattern of the respondents

It is natural that at any recreational site in most of the cases the number of visitors living close to that place would be more than those living at a far distance. It is also evident from the study. As the study area is located near Mirpur area, more than half of the respondents (56.5%) have come from Mirpur and its adjacent areas to the site. Other some origins of travel to the site are Dhanmondi, Old Dhaka, Gulshan, Banani, Azimpur etc. It takes only 10-30 minutes for half of the visitors to reach to the site (Appendix B, Table B2).



Source: Field Survey, July, 2011.

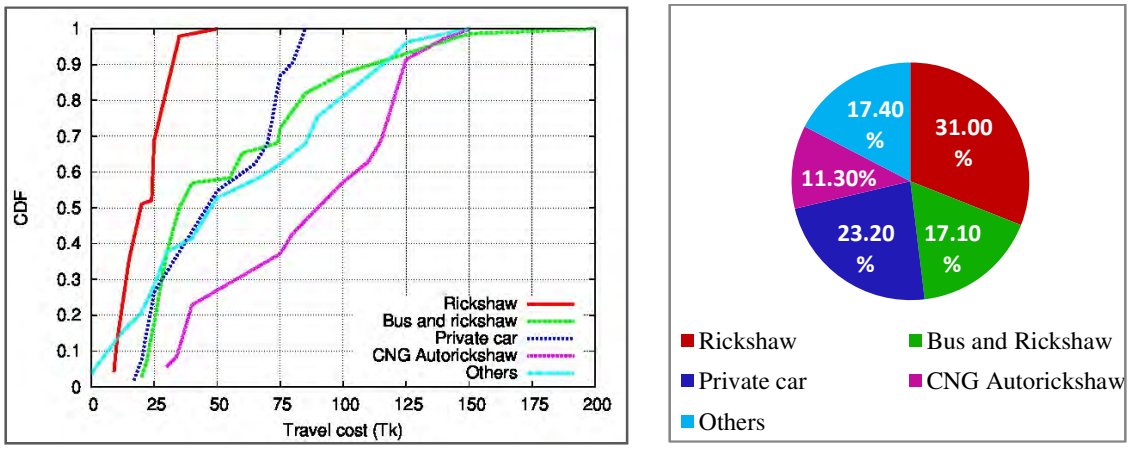
Figure 7.3: Distribution of Visitors (in percentage) Based on the Frequency of Visit to the Site

The ITCM is based on an individual's visits, where an individual may make any number of visits in a year, but most make either one or two, though a few may make weekly or daily visits (Wills and Garrod, 1991). Figure 7.3 shows that nearly one-third of total visitors visit the site for two times in a year. The immediate next larger fractions of visitors (28.10%) are those who visit the site on a random basis. Visitors who live at closer location visit the site more frequently. It is evident from Table 7.3 in which it can be seen that most of the visits that are made on weekly and monthly basis are travelled by rickshaw. That means most of the frequently visited trips are made within rickshaw distance (within 1-2 km from the site).

Table 7.3: Distribution of Visitors (in percentage) Based on Their Choice of Mode and Frequency of Visit to the Site

	Frequency of Visit to the Site					
Mode of Transport	Weekly	Monthly	Half yearly	Yearly	Randomly	**Total**
Bus	0.0	1.0	1.9	0.0	1.3	4.2
Bus and Rickshaw	1.0	2.9	4.5	1.9	6.8	17.1
CNG	0.0	0.0	3.5	3.5	4.2	11.3
CNG and Rickshaw	0.0	0.0	0.0	0.0	0.3	0.3
Motorcycle	1.3	0.3	1.6	0.6	1.9	5.8
Private car	1.3	2.6	10.0	4.2	5.2	23.2
Rickshaw	4.2	**10.6**	9.4	2.9	3.9	**31.0**
Taxicab	0.0	0.0	0.0	1.3	1.6	2.9
Troller	0.0	0.0	0.0	0.6	2.9	3.5
Walking	0.6	0.0	0.0	0.0	0.0	0.6
Total	8.4	17.4	31.0	15.2	28.1	100.0

Source: Field Survey, July, 2011.



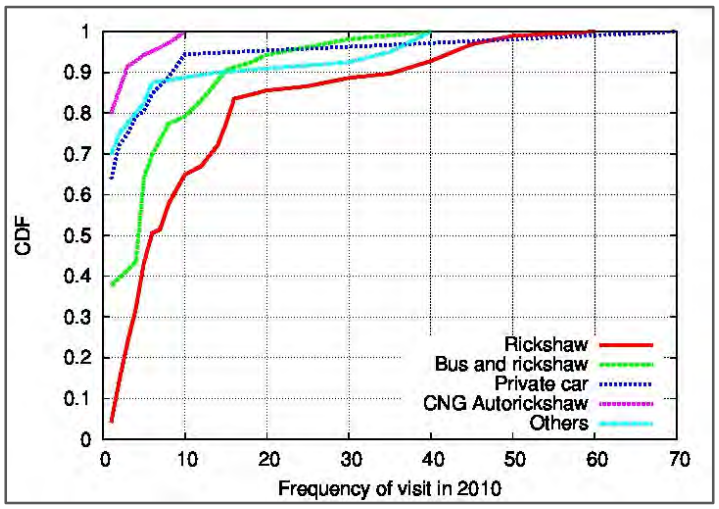
Source: Field Survey, July, 2011

Figure 7.4: (Left) Cumulative Distribution of Travel Cost for Different Modes of Transport, (Right) Distribution of Trips by Different Modes of Transport

It can be seen from Figure 7.4 (right) that large fraction of trips to the site are made by rickshaw, which is the cheapest mode of transport among the modes by which people travel to the site (for instance, it never exceeds Tk. 50 per visit, Figure 7.4 (left)). When visitors use bus and rickshaw together in 65% cases the travel cost is almost equal to that of using private cars. It is interesting to see that in nearly 20% cases, using bus and rickshaw becomes more expensive than using private cars (Figure 7.4 (left)). One possible reason is that private cars are run by cheaper fuel such as compressed natural gas, which makes them cheaper for long distance travels compared to using bus and rickshaw together. It is also seen that CNG auto-rickshaws (nearly 12% of trips, Figure 7.4 (right)) are expensive exceeding Tk. 100 per visit in more than 50% cases.

It can be seen from Figure 7.5 that rickshaw is the most popular means of transport to visit the site and CNG auto-rickshaw is the least one. That means, people within rickshaw distance (say within 1-2km from the site) visit the site more frequently than people who visit by other means. This happens because rickshaw is the cheapest of all transport choices (Figure 7.4 (left)). It is also observed that the frequency of visit is rather low (around 10 or fewer), and the fraction of visitors visiting the site more than 10 times in a year is never greater than 35% (even by using rickshaw). In other

transport choices, it's even smaller (zero for CNG Auto-rickshaw). It implies that using expensive means of transport reduces the frequency of visits.



Source: Field Survey, July, 2011

Figure 7.5: Cumulative Distribution of Frequency of Visit in 2010 for Different Modes of Transport

The temporal dimensions of the site are summarized in Table 7.4 where it can be observed that the preferable season for majority of visitors (66.5%) to visit the site is rainy season. It can be justified by analyzing the opinions of the visitors while they are asked about the attractive features of the site during the questionnaire survey. Most of the visitors have told that they usually come to the site to enjoy the scenic beauty of the wetland when it is full of water during rainy season and also to enjoy boating at that time (Field survey, 2011).

Generally people visit recreational site in weekends and data in the study also reveals this fact. About 85% of the visitors prefer afternoon to visit the site. The possible reason for that choice may be the calm and quiet environment of the site within that period of time (3 pm to 6 pm).

Table 7.4: Preferences of the visitors about season, day and time to visit the site

Preferences		Percent (%)
Preferable Season	Winter	13.9
	Rainy	**66.5**
	Summer	8.1
	Autumn	3.5
	Any Season	6.1
	Spring	1.9
Preferable Day	Anyday	20
	Weekday	2.3
	Weekend	**77.7**
Preferable Time	Morning	0.3
	Noon	8.4
	Afternoon	**85.2**
	Anytime	6.1

Source: Field Survey, July, 2011.

7.4.2 Determining the Recreational Benefit of the Site by ITCM

Travel cost method is based on the theory of consumer demand. The fundamental principle of TCM is that the value people attach to a non-market goods or service like a recreational site can be derived from their travel consumption to that site, which is the cost they incur in traveling to it. The summation of the direct cost derived from consuming the environmental service and the consumer surplus defines the price of the non-market goods (Tang, 2009).

7.4.2.1 The econometric model for the trip generating function

According to Garrod and Willis (2001), the trip generating function of individual travel cost method (ITCM) can be defined as:

$V_{ij} = f(P_{ij}, T_{ij}, Q_i, S_j, Y_i)$

Where, V_{ij} = the number of visits made by individual i to site j

P_{ij} = the travel cost incurred by individual i when visiting site j

T_{ij} = the time cost incurred by individual i when visiting site j

Q_i = a vector of the perceived qualities of the recreation site i

S_j = a vector of the characteristics of available substitute sites

Y_i = the household income of individual i

ITCM requires researchers to conduct an on-site questionnaire survey of the visitors to collect data on household or individual visit frequencies over a given time period, cost of travel to the site, recreational preferences, use of substitute sites and socio-economic characteristics like age, gender, income etc. These data are used to specify trip generating function as well as to derive a demand curve from which consumer surplus can be estimated (Garrod and Willis, 2001).

Economic theory does not suggest any particular functional form for TCM. Linear, log-linear, linear-log and double-log functional forms are most commonly applied to form demand function (Garrod and Willis, 2001). Ward and Beal (2000) have noted that among these functional forms the linear form is the most commonly estimated form and can easily be interpreted and explained. But this form implies a critical cost above which the model predicts that negative visits will be demanded. Whereas log-linear functional form implies a finite number of visits at zero cost and never predicts negative visits even at very high cost. This form has been widely used in travel cost models (Garrod and Willis, 2001). Due to the above mentioned reasons and the consistency with the data in the study log-linear functional form is applied to form the demand model.

7.4.2.2 The specifications of the econometric model

Econometrics is both a statistical and mathematical tool used for giving empirical evidence for a chosen model (Bulov and Lundgren, 2007). In the econometric model of ITCM the independent variable is the number of trips made during a year and its associated trip costs, demographic factors and income of the visitors are the dependent variables. The assumptions and definitions that are applied for different independent variables included in the econometric model are mentioned below:

(a) Time cost

The issue of pricing time which is partly spent on traveling to a recreational trip and partly at the site has come from the notion of opportunity cost of time. If a person wishes to visit a recreational site he/she must give up a portion of his/her income that can be earned by investing that time at work place (Hanley and Spash, 1993).

Freeman (1993) emphasizes that the opportunity cost of time must be included in travel cost and failure to do so will reduce the estimated benefits of visiting the recreation site. Various attempts have been taken to address this issue. There is no clear answer of how to define the time cost (Pearce and Turner, 1990).

Despite some criticisms the most common way to estimate time cost is wage based method as suggested by Cesario (1976), in which the time lost on travelling can be valued by one-third of the hourly wage rate. Many researchers apply this method to valuate time cost in their research (Tang, 2009; Gurluk and Rehber, 2007; Bulov and Lundgren, 2007 and Mahat, 2004). Hence, in the study the opportunity cost of time is calculated in the same way by using the following formula:

Time cost = 1/3 x (Monthly individual income/ Working hours per month)

Here, the number of working hours per month is assumed to be 208 according to the International Labor Organization (2007) where the standard amount of working hours per week is mentioned as 48 (Bulov and Lundgren, 2007). Parsons (2003) has mentioned that time cost consists of the time spent in traveling to and from the site and time consumed on the site. Thus, in the study time cost is calculated for both the travel time and on-site time.

(b) Components of travel cost

Total travel cost includes travel cost (to and from the site), entrance fee including fee for the vehicle entry, on-site expenditure (food cost, boating cost) and time cost (Parsons, 2003). In the study, total travel cost is estimated by including all these costs. It has to be mentioned that in the study area the entry fee is Tk 10 per person, parking fee is Tk 10-20 per vehicle and boating fee ranges from Tk 100 to 250 per trip (Field survey, 2011).

(c) Socio-economic and other factors

The frequency of visit to the site in a year is influenced by a number of socio-economic factors such as age, gender, occupation, level of education, time flexibility, income etc (Parsons, 2003). In the study demographic data are collected on age,

gender, educational qualification, occupation of the visitors. Apart from these factors data are also collected on monthly individual income of the visitors, their expenditure on recreation and the mode of transport by which they visit the site. Among these variables gender, educational qualification, occupation and mode of transport are qualitative variables. Dummy variables can be used as a way to introduce qualitative variables into regression model. By doing so, the results can be shown and interpreted if the qualitative variables has any statistical significance for the chosen model (Dougherty, 2002 cited in Bulov and Lundgren, 2007).

The variables with qualitative nature are used as dummy variables in the regression model in the study. The gender variable is given value 1 if the respondent is male and 0 for female. Similarly visitors with level of education of HSC is given value 1, otherwise 0; Students are given 1 value and other occupations are given 0 and if the visitors travel to the site only by rickshaw then the variable is given 1, otherwise 0.

(d) Multiple destination trips

Considering the trip cost for the particular visit of the site is the most commonly used approach when the number of the MDT visitors is limited (Gurluk and Rehber, 2008). As in the study area the MDT visitors are very limited (1.41%), so considering their trip cost related to that particular trip for reaching the site is justified (Field survey, 2011).

(e) Substitute sites

Many researchers have given their opinion that there is no single method for specifying quality and price of the environmental goods that account for substitute effects (Kling, 1987; Bockstael et al., 1991 and Bateman, 1993 cited in Gurluk and Rehber, 2008). Rosenthal (1987) has stated that when substitute prices are reflected by the statistical analysis, it will cause multi-collinearity problem with the price of the related recreational site. Moreover, a question may arise whether any nature-based recreational area, which is unique, has any substitute or not (Gurluk and Rehber, 2008). A substitute for one visitor may be another such nature-based recreation site whereas the substitute site for another may be watching sport in a

stadium. Thus there are lots of difficulties in obtaining substitute data and considering its effect in recreational demand function.

Most of the visitors (97.7%) in the study area have stated that the site is unique and there is no substitute of this site. Examining all these facts substitute price effects are not included in the regression analysis of the study.

7.4.2.3 Results and interpretations

In order to estimate the consumer surplus, which will determine the recreational value of the site and set up its demand model and to determine the effects of different factors on the number of visits made by individuals in a year, a multiple regression analysis is done by selecting the frequency of visit made by individuals in the year 2010 as dependent variable and travel cost and other socio-economic variables related to the visitors as independent variables. The list of the variables included in multiple regression equation is shown in the following table:

Table 7.5: List of variables used in regression equation of the demand function

Variables	Elaboration
V	Frequency of visit made by individuals to the site in the year 2010
TC	Total Travel cost to and from the site including entry fee, food cost, parking cost, boating cost
G	Dummy variable used for gender of the visitors, indicates 1 for male and 0 for female
A	Age of the visitors
E	Dummy variable used for educational qualification of the visitors, indicates 1 for HSC and 0 for others
O	Dummy variable used for occupation of the visitors, indicates 1 for students and 0 for others
I	Monthly individual income of the visitors
ER	Monthly expenditure on recreation of the visitors
MT	Dummy variable used for mode of transport by which the visitors travel to the site, indicates 1 for rickshaw and 0 for others

In the study multiple regression equation is generated by using SPSS 17.0 software. Among different types of multiple regression analyses, standard multiple regression is used where all the independent variables are entered into the equation simultaneously. This is the most commonly used multiple regression analysis. This approach show how much unique variance in the dependent variable each of the independent variable can explain. The results of the multiple regression analysis are shown in the following table:

Table 7.6: Results from Regression Analysis of the Trip Generating Function

Model Summary						
Model	R	R^2	Adjusted R^2		Std. Error of the Estimate	
Log-linear	.533	**0.285**	0.266		1.04483	
ANOVA						
Model type	Model	Sum of Squares	df	Mean Square	F	Sig.
Log-linear	Regression	130.724	8	16.341	14.968	.000
	Residual	328.591	301	1.092		
	Total	459.315	309			
Co-efficients						
Dependent variable	Model variables	Co-efficients	Std. Error of the Estimate		T	Sig.
ln (V)	(Constant)	1.259	0.344		3.662	0.000
	Travel cost (TC)	-0.001	0.000		-4.821	**0.000**
	Gender (G)	0.052	0.137		0.38	0.705
	Age (A)	0.000	0.010		0.045	0.964
	Educational qualification (E)	0.127	0.124		1.026	0.306
	Occupation (O)	-0.100	0.169		-0.592	0.554
	Income (I)	0.000	0.000		1.004	0.316
	Expenditure on recreation (ER)	0.000	0.000		0.848	0.397
	Mode of transport (MT)	1.024	0.137		7.482	**0.000**

Source: Field survey, July, 2011

Interpretation of output from multiple regression is given below:

Step 1: Checking the assumptions

(a) Multicollinearity

Multicollinearity exists when the independent variables are highly correlated (r= 0.7 or above). Multiple regression does not consider multicollinearity. To check it a correlation matrix is formed which shows the correlations between each independent variable and the dependent variable as well as the correlation among the independent variables (Appendix C, Table C1). It can be seen from the correlation matrix is that the correlation between each of the independent variables is not high. The largest correlation exists between monthly individual income and monthly expenditure on recreation- 0.685, which is not large enough to cause a problem.

(b) Linearity and Normality

To check the linearity between dependent variable and each independent variable scatter diagrams are plotted and the diagrams prove the linear relationship between dependent and each independent variable. By a the Normal P-P Plot, it is seen that the points lie in a reasonably straight diagonal line from bottom left to top right, which suggest no major deviations from normality (Appendix C, Figure C1).

Step 2: Evaluating the model

The co-efficient of determination, R^2 measures the proportion of the variation in the dependent variable explained by the independent variables. A higher R^2 would imply that the calculated regression equation line fits closer to the data points (Ahmad, 1994 cited in Azyyati et al., 2007).

The $\mathbf{R^2}$ for the regression equation of the study is 28.5% (Table 7.6 (model summery)), this means that the model explains 28.5% of the variance in frequency of visit per year. The value is seen to be low which means that there may be other possible variables that may influence the visit decision which are not included in the model.

To assess the statistical significance of the result, it is necessary to notice ANOVA table (Table 7.6). In this table the computed **F value** is given as 14.97 which exceeds the critical value of F which is 1.94 (at 0.05 significance level). It can be concluded that at least one of the regression coefficient is not equal to zero. The *p*- value is 0.000, so there is little chance that null hypothesis is actually true.

Step 3: Evaluating each of the independent variables

To compare the contribution of each independent variable, beta values under the Table C2, Appendix C labeled as co-efficients can be observed. The larger **Beta** co-efficients are 0.389 for **mode of transport** and 0.319 for **travel cost** (ignoring any negative signs). This means that these variables make the stronger unique contribution to explain the dependent variable, when the variance explained by all other variables in the model is controlled for. The Beta values for other variables are very low, indicating there less contribution in the model.

The column labeled as **Sig.** in Table 7.6 (co-efficient) show whether the variable is making a statistically significant unique contribution to the equation or not. If the **Sig.** value is less than 0.05, the variable is making a significant unique contribution to the prediction of the dependent variable. And if the value is greater than 0.05, it can be said that that variable is not making significant unique contribution in the prediction of dependent variable. From the **Sig.** value of this table it can be seen that only **travel cost** and **mode of transport** make a unique and statistically significant contribution to the prediction of frequency of visit in a year, because in case of other variables the Sig. value is much greater than 0.05.

The **Part** correlation coefficients in Appendix C, Table C2 give an indication of how much of the total variance in the dependent variable is uniquely explained by each variable. In the study, **travel cost** uniquely explains 5.5% of the variance in frequency of visit in a year whereas **mode of transport** can uniquely explain 13.3% of the variance. Rest of the variables put very poor contribution to the total R^2 value.

7.4.2.4 The demand function and the demand curve

According to the regression results summarized in Table 7.6, only two independent variables are included in the regression model. These are total travel cost (TC) incurred by the visitors to visit the site and mode of transport (MT) by which the visitors travel to the site. Other variables are omitted from the model because of their insignificant contribution to the prediction of the number of visits to the site in a year. Considering the variables in the regression model, the demand function for the site is developed as follows:

$$\mathbf{ln(V) = 1.259 - 0.001 \times TC + 1.024 \times MT}$$

It is seen in Table 7.6 and demand model that the sign of total travel cost is negative (-). According to the theoretical framework this seems correct that the number of visits made by an individual in a year decrease as the travel cost increase. But since the value of co-efficient is close to zero, which implies that a change in travel cost has little effect on how many visits that would be made in a year to the site.

The demand curve for the site for recreation is also developed by using above mentioned demand function which is shown in Figure 7.6. In this figure there is an inverse relationship between the number of annual visitors and the cost of travelling to the site.

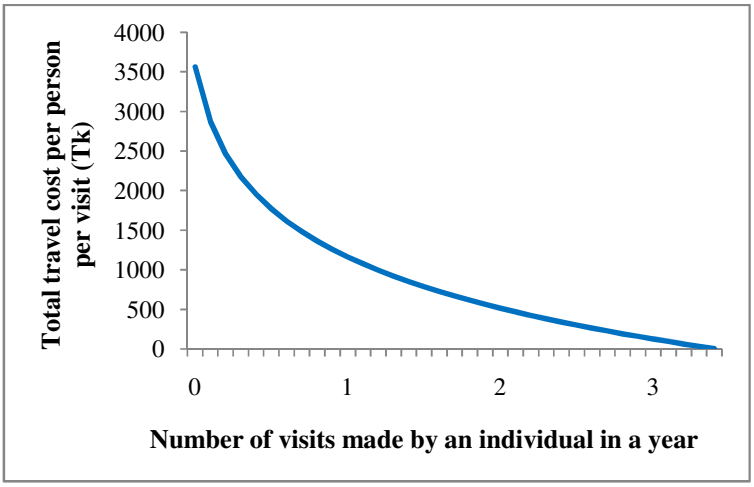


Figure 7.6: Demand Curve for Recreational Visits to the Site

7.4.2.5 Consumer surplus

The basic principle of TCM is the estimation of the consumer surplus (CS) (Gurluk and Rehber, 2008). Consumer surplus is expressed as the difference between the price visitors are willing to pay and the actual price paid to visit the recreational site:

$$CS = Willingness\ to\ pay - actual\ pay$$

According to Garrod and Willis (2001), in case of log-linear functional form the consumer surplus (*CS*) for an individual making q visits to the site can be calculated by the following formula:

$$CS = -q/\beta$$

Where, β = Co-efficient of travel cost (usually negative)

And the consumer surplus for an individual per visit is: $CS = -1/\beta$

Total recreational value of the site in the year 2010 is estimated by adding the aggregated consumer surplus and total travel cost incurred by the visitors in the same year. All required calculation is shown in Table 7.7. Based on the total number of visitors in the site in 2010, the calculated total recreational value of the site is Tk 18,22,51,746 (USD 2.25 million, 1 USD= Tk 81) (Table 7.7).

Table 7.7: Consumer Surplus, Total Travel Cost and Recreational Value of the Site in the Year 2010

Total number of visitors in the year 2010 (persons/year)	127800
Consumer surplus	
Individual consumer surplus (Tk/person/visit)	1000
Total consumer surplus (Tk/year)	12,78,00,000
Travel cost	
Individual travel cost on an average (Tk/person/visit)	426.07
Total travel cost (Tk/year)	5,44,51,746
Recreational value of the site (total consumer surplus + total travel cost) (Tk/year)	18,22,51,746 **(USD 2.25 million)**

Source: Field survey, July, 2011

7.4.2.6 Present value of recreational benefits from the site

As the starting of November in the year 2010 is assumed as the base year for calculation of agricultural products and fisheries, so the recreational benefits are to be calculated for the same base year. Otherwise total value of each of the functions cannot be aggregated for the same year to derive the total valuation of the site. The calculated recreational benefits are obtained at the end of the 2010, so this benefit is 'Future Value Benefit' and the 'Present Value Benefit' can be derived by the following formula:

$$PVB = \frac{FVB}{(1+r)^n}$$

$$= \frac{182251746}{(1+0.1)^{1/12}}$$

= Tk 180,809,942

Here discounting rate is taken as 10%, because at present the interest rate on fixed deposit account in government banks of Bangladesh is 10% in a year.

7.5 Conclusion

The study may be biased by the following facts. Data in the study has been collected through personal interview where personal biases may be higher especially in case of information to the economic status of the respondents. The calculation of time cost may be biased by the fact that one-third of the daily wage has been used in the study based on TCM studies carried out elsewhere in the world and may not be correct for this study.

Due to the limitation of time, questionnaire survey is only conducted during weekends of the month. If the survey could be conducted throughout the month then the information about the weekday visitors, their opinion could be obtained. Moreover, if the establishment costs of the recreational settings can be collected then the analysis could be more animated. In this study, only the recreational value of the site is estimated, no cost analysis of the recreational site is made.

Chapter 8: Valuation of Flood Control and Ground Water Recharge Function

8.1 Introduction

Due to their biological, ecological, social, cultural and economic values, wetlands are the most productive ecosystems in the world. Wetlands provide a wide variety of indirect benefits such as nutrient retention, flood control, storm protection, ground water recharge and other such services. The study is only confined with estimating the indirect benefits from the flood control and ground water recharge functions of wetland and this chapter discusses about the valuation techniques of these two important functions.

Wetlands function as natural sponges that trap and slowly release surface water, rain, snowmelt and flood waters over time. Trees, root mats, and other wetland vegetation also slow the speed of flood waters and distributes them more slowly over the floodplain. Wetlands and adjacent floodplains often form natural floodways that convey flood waters from upland to downstream points. This combined water storage and braking action lowers downstream flood heights and protecting downstream property owners from flood damage. Wetlands within and downstream of urban areas are particularly valuable, counteracting the greatly increased rate and volume of surface water runoff from pavement and buildings. The holding capacity of wetlands thus helps in controlling floods.

Aquifers and groundwater are recharged with water by precipitation that seeps into the ground and by surface waters. Wetlands connected to groundwater systems or aquifers are important areas for groundwater exchange. They retain water and so provide time for infiltration to occur. Groundwater, in turn, provides water for drinking, irrigation, and maintenance of stream flow and lake and reservoir levels. During periods of low stream flow the slow discharge of groundwater often helps maintain minimum water levels. The intricate connections of wetland with groundwater, stream flow, and lake and reservoir water levels make them essential in the proper functioning of the hydrologic cycle (Michaud, 2001).

8.2 Method Used for Valuation

8.2.1 Flood Control Function

Some valuation techniques estimate benefits directly while some others estimate costs as a proxy for benefits. For instance, in Damage Cost Avoided method the costs that would be incurred if the ecosystem function were not present are used as a reasonable approximation of the benefits that the society attributes to the resources. The underlying assumption is that the benefits are as great as the costs involved in repairing, avoiding or compensating for damage (Turner et al., 2003).

In the study, the economic value of flood prevention function of wetland is estimated by using the Damage Cost Avoided method. This method is to calculate either the monetary value of potential property damage, or the amount that people spend to avoid such damage.

That means the Damage Cost Avoided method can be applied by using two different approaches. One approach is to estimate potential damages to property if flooding were to occur. In this case, the researcher would estimate the probable damages to property if the wetlands are not preserved. A second approach would be to determine whether nearby property owners have spent money to protect their property from the possibility of flood damage, for example by purchasing additional insurance or by reinforcing their basements. These avoidance expenditures would be summed over all affected properties to provide an estimate of the benefits from increased flood protection. However, the two approaches do not produce the same estimate. If avoidance costs are expected to be less than the possible damages, people would pay to avoid those damages (King and Mazzotta, 2000). In our study, the monetary value of potential flood damage is estimated to valuate the flood control function of the study area. This estimation assumes that the flood damage would incur due to the absence of the wetlands in its present form.

8.2.2 Ground Water Recharge Function

The amount of moisture that will eventually reach the water table is defined as groundwater recharge. The amount of this recharge depends upon the rate and duration of rainfall, the subsequent conditions at the upper boundary, the soil moisture conditions, the water table depth and the soil type. Groundwater recharge enters the aquifer in a very irregular way both in terms of seasonal variation and the variation between years.

Estimating the rate of aquifer replenishment is the most difficult one of all measures in the evaluation of groundwater resources. Estimates are normally and almost indispensably subject to large error. No single comprehensive estimation technique can yet be identified from the spectrum of those available, which gives reliable results.

Rainfall is the most important source of ground water recharge. Based on the studies undertaken by different scientists and organizations regarding correlation of ground water recharge fluctuation and rainfall, some empirical relationships have been developed for computation of natural recharge to ground water from rainfall. One of these empirical formulas is the 'Chaturvedi Formula', widely used in India (Kumar, 2004).

In our study while valuing the ground water recharge function of the study area at first annual quantity of recharged ground water is estimated by using the Chaturvedi formula and then this quantity of water is valuated. The formula is discussed below:

Based on the water level fluctuations and rainfall amounts in Ganga-Yamuna doab, Chaturvedi in 1973, derived an empirical relationship to arrive at the recharge as a function of annual precipitation (when rainfall exceeds 40 cm) is given below:

$$R_r = 2.0\ (P - 15)^{0.4}$$

Where,

R_r = Net recharge due to precipitation during the year, in inches; and

P = Annual precipitation, in inches.

This formula was later modified by further work at the U.P. Irrigation Research Institute, Roorkee and the modified form of the formula is-

$$R_r = 1.35\ (P - 14)^{0.5}$$

The Chaturvedi formula has been widely used for preliminary estimations of groundwater recharge due to rainfall. It may be noted that there is a lower limit of the rainfall below which the recharge due to rainfall is zero. The percentage of rainfall recharged commences from zero at P = 14 inches, increases upto 18% at P = 28 inches, and again decreases. The lower limit of rainfall in the formula may account for the soil moisture deficit, the interception losses and potential evaporation (Kumar, 2004).

After quantifying the recharged ground water it is then valuated by applying the market cost of making this water usable (Detail in later section). In true, ground water services are difficult to evaluate because much of the information required for valuation is not readily available. Market trades can provide useful data for valuation, but most of the services provided by ground water are not traded in market (Canter et al., 1997).

8.3 Data Collection Procedure

All required data for the calculation of economic values of flood control function and ground water recharge function of the floodplains under the study are collected mainly from Bangladesh Water Development Board (BWDB). Moreover, some relevant literature like published and unpublished books, reports, journals and web documents are also reviewed to develop the concepts and to have required data for the assessment methods.

8.4 Data Analysis

8.4.1 Valuation of Flood Control Function

It is previously mentioned that the flood control function of the study area is valuated by estimating the cost of damage which would occur if the floodplains are filled up

or not preserved. To serve this purpose at first the inundation areas of the floodplains are calculated. Inundation area is derived for both Uttar kaundia and Goran chatbari mouza (Appendix D).

Step 1: Calculation of Inundation Areas

At the first stage of the calculation, total area is divided into some small pockets of areas. Within those small pockets at certain points land elevation data are collected. To find out the depth at those certain points their data of elevation are deducted from datum. Here datum is assumed considering the average elevation of surrounding land area. Then the volume of the retained water in those small pockets of areas is estimated by multiplying the average depth with their respective areas. The aggregated volume of retained water is derived by summing up the volume of water in all the small pockets of areas that is calculated previously. After that, the area of inundation is calculated by dividing the volume of retained water by the depth of inundation of flood during 2007. Detail calculation is shown in Appendix D (Table D1 and Table D2).

Finally, it is calculated that total 1535.21 acre of area would be inundated with the flood level of 1.5 m (Flood level during the flood of 2007) if the floodplains of the study area are filled up or not preserved.

Step 2: Calculation of Flood Affected People

In the Detailed Area Plan (DAP), residential land uses are categorized into three types. The respective population density of those three categories is also proposed in DAP. From the field survey and google earth image it is identified that the settlements, occupation pattern etc of the surrounding area of the study area are similar to rural homestead category.

For rural homestead type of settlement proposed population density is 15 persons per acre. According to the previous calculation of inundation areas and the proposed population density, if total inundated area due to flood is 1535.21 acre then total number of affected people would be 23028 persons.

Step 3: Calculation of Loss due to Flood

Due to the unavailability of data and the extent of the study, flood loss is calculated only by considering the number of affected people. Losses in other sectors due to flood such as crops, infrastructure, housing etc are not calculated here.

The duration of flood in the year 2007 in the study area is 26 days (BWDB, 2007). It is assumed that in those days people are stuck at home by the flood water, could not go outside for work and earn money. The World Bank sets the income poverty line at US$ 1.25 a day per person in 2008 for international comparisons. Here, the poverty line is determined by finding the total cost of all essential resources that an average human adult consumes in a year (The World Bank, 2008). Due to the data unavailability it is also assumed that in the year 2010, the extent and duration of flood was just like the flood occurred in 2007. Thus, by considering all these factors the monetary loss to the affected people due to flood in the year 2010 is calculated and is shown below:

Proposed Population Density = 15 (persons/acre)

Total number of affected people = 23028

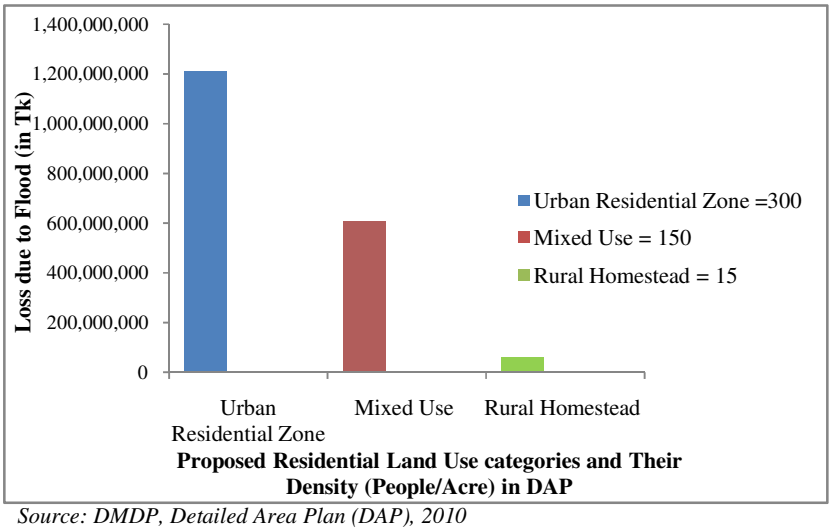
Duration of Inundation = 26 days

Total loss due to flood = $1.25 x 26 x 23028

= Tk 101.25 x 26 x 23028 [$1 = Tk 81]

= Tk 60,621,519

This estimation of flood loss would vary with different density of population. Figure 8.1 shows category wise different population density and their respective flood loss.



Source: DMDP, Detailed Area Plan (DAP), 2010

Figure 8.1: Loss due to flood (in Tk) in different proposed residential land use categories in DAP

8.4.2 Valuation of Ground Water Recharge Function

Step 1: Calculation of Recharged Quantity of Ground Water

At first the quantity of ground water recharge in a year in the study area is determined by using the following modified Chaturvedi formula:

$R_r = 1.35\ (P - 14)^{0.5}$

$= 1.35\ (80\text{-}14)^{0.5}$

$= 10.97$ inch/year

Here, the average annual rainfall in Dhaka is 2000mm = 80 inch (BWDB, 2010)

As the total area of the floodplains is 2656.355 acre, the volume of this recharged ground water (in cubic meter) in the study area in a year will be as follows:

$= R_r \times Total\ area\ of\ the\ floodplains$

$= 0.278\ m\ \times 10749887.29\ m^2$ [1 inch= 0.0254 m and 1 acre = 4046.8564 m^2]

$= 2988468.67\ m^3$

Step 2: Pricing of Recharged Ground Water

Dhaka Water and Sewerage Authority (DWASA), a government controlled service organization is solely responsible for providing water to the residences, industries and commercial establishments of Dhaka city. It supplies water to the inhabitants of Dhaka by their deep tube-wells and surface water treatment plants. A good quality of ground water is extracted by those deep tube-wells from the aquifer extending between 50 to 120 meter (Anwar, 2010).

A substantial amount of energy (electricity) is expended to pump out and treat the ground water for our use. The average energy expenditure of different pump stations for the production of one cubic meter water from the deep tube-wells by DWASA is used to valuate the recharged quantity of ground water in a year in the study area.

From Appendix D, Table D3, it is calculated that on an average Tk 1.39 is spent in a month for the production of 1 cubic meter water through deep tube-wells by DWASA. That means, in the year 2010 on an average Tk 17 is spent by DWASA for the production of 1 cubic meter of water.

Accordingly, the price of the recharged ground water in the study area in the year 2010 would be-

$$= Total\ Recharged\ quantity\ of\ ground\ water \times Production\ cost\ of\ one\ unit\ of\ water$$

$$= 2988468.67 \times 17$$

$$= Tk\ 5{,}08{,}03{,}967$$

8.5 Conclusion

The valuation process of flood control function and ground water recharge function of wetland is a very complex process. In the study, due to the unavailability of data and time constraints, flood damage is only calculated by considering the number of affected people. Loss in other sectors is not calculated here. Another constraint is, as in whole of the study the year 2010 is considered as the base year, but the data of

flood scenario for this year is unavailable. That is why it is assumed that the extent of flood for the year 2007 is as same as the year of 2010.

Ground water recharge function of wetlands is difficult to valuate, because most of the services provided by ground water are not traded in market. Techniques exist to valuate the non-market benefits like contingent valuation method, but the time constraint of the study restrains to go through such complex method.

Chapter 9: Major Findings, Policy Implications and Conclusion

9.1 Introduction

This chapter summarizes the findings of the whole study. The method of valuation, data collection and data analysis process for evaluating each of the direct and indirect use benefits of the floodplains of the study area are elaborately discussed in the previous chapters. The quantitative value of each of the goods and services provided by these wetlands are summarized and policy implications of this research are presented in this chapter. Total valuation assessment approach is used to assign the value of the floodplains in terms of Taka and also in dollar.

9.2 Major Findings from the Study

Major findings of the direct use values of floodplains of the study area such as agriculture, fisheries and recreation are discussed below:

(a) Agriculture

The valuation of agricultural products is derived from **market price method**. In the study area, people only cultivate IRRI paddy in the dry season. It is previously mentioned that the 'point of first sale' or 'farm-gate price'- the price that the owner of the land receives when he sells his product is considered in the study for the valuation of the product.

The owner of the land sells the paddy at the rate of Tk 21,000 per MT. If 5.58 MT of paddy is yielded from one hectare of land in a year, then price of paddy per hectare goes to around Tk 117,160. By adding the selling price of the straw produced from one hectare of land total price of paddy becomes Tk 122,160 per hectare.

As the starting of November in the year 2010 is assumed as the base year for calculation and benefits are incurred by the owner after six months, then the present value of benefit goes to Tk 1,16,475 per hectare (at the discount rate of 10%). And this is the value of per hectare agricultural product in the year of 2010 from the study

area. As the total area of the study area is of 2656.355 acre or 1075.012 hectare (1 hectare = 2.471 acre), so **the total value of agricultural products from the site in the year 2010 is Tk 125,212,039.**

This agricultural project is beneficial for the owner of the land because here per hectare cost of production is Tk 86,062 whereas the net benefit obtained from the production is Tk 30,413 per hectare, which provides a beneficial indication.

(b) Fisheries

Wetlands are an obvious source of water for fishing. People cultivate fishes two times in a year during rainy season in the study area. The economic benefits of fisheries are derived in the study from just as the same way as for agricultural products, that means from **market price method**.

The owner of the land sells fishes at the rate of Tk 70,000 per MT. If 2.5 MT of fishes are extracted from one hectare of land in one cycle of production in a year, then the price of fishes per hectare goes to around Tk 175,000.

As the starting of November in the year 2010 is assumed as the base year for calculation and if it is also assumed that all the benefits (total benefits of two cycles) are incurred by the owner after six months of his investment (total investments of two cycles), then the present value of benefit in the production goes to Tk 318,182 per hectare (at the discount rate of 10%). And this is the value of fisheries per hectare in the year of 2010 from the study area. While the total area of the study area is of 2656.355 acre or 1075.012 hectare, **the total value of production from fishing from the site in the year 2010 is Tk 342,049,513**.

Production of fishes in the study area is beneficial for the owner of the land because here per hectare cost of production in two cycles is Tk 139,000 whereas the net benefit obtained from two cycles of production is Tk 185,651 per hectare, which provides a beneficial indication. It also indicates that production of fishes in a year is more beneficial than production of paddy and observing net benefits it can be said that fisheries provide more than six times benefits than paddy.

(c) Recreation

The study area acts as an attractive place of recreation for the city dwellers particularly during rainy season. The recreational value of the site is determined by **travel cost method**. A recreational demand function and a demand curve are developed for the site. From the demand curve the estimated consumer surplus per year is Tk 127,800,000 and the **total recreational value of the site in the year 2010 is Tk 180,809,942.**

Major findings of the direct use values of floodplains of the study area such as agriculture, fisheries and recreation are discussed below:

(d) Flood Control Function

In the study, the flood control function of the site is estimated by **Damage Cost Avoided method**. In this method the monetary value of potential flood damage is estimated to valuate the flood control function of the study area. This estimation assumes the flood damage incurred due to the absence of the wetlands in its present form. **The estimated potential loss due to flood in the site in the year 2010 is Tk 60,621,519.**

(e) Ground Water Recharge Function

To valuate the ground water recharge function of the site at first total recharge quantity in a year is estimated than the quantity is valuated. The average energy expenditure of different pump stations for the production of one cubic meter water from the deep tube-wells by DWASA is used to valuate the recharged quantity of ground water in a year in the study area. **The estimated total value of the recharged ground water in the study area in the year 2010 is Tk 50,803,967.**

The total economic value of the site derived from its direct and indirect use values are shown in the following Table 9.1:

Table 8.1: Valuation of the Floodplains of the Study Area in the Year 2010

Use Values		**Annual value (in Tk)**
Direct	Agriculture	125,212,039
	Fisheries	342,049,513
	Recreation	180,809,942
Indirect	Flood control	60,621,519
	Ground water recharge	50,803,967
Total annual value		**= Tk 759,496,980** **= Tk 759.5 million** **= USD 9.38 million** [1USD= Tk 81]
Total annual value per hectare		**= Tk 706,501** **= Tk 0.71 million** **= USD 0.0087 million**

Thus, the total economic value of the flood plains in the study in the year 2010 is Tk 759.5 million and per hectare economic value of the site is Tk 0.71 million or USD 0.0087 million.

9.3 Policy Implications

Dhaka is bounded all around by many rivers and crisscrossed by numerous canals. In addition, it is surrounded by a significant amount of depressed land, marshes, low lying areas and flood plains. Due to rapid urbanization in Dhaka, there is an increasing need for housing, roads, commercial, industrial and other facilities. To cater this need the city is expanded outward but in an unplanned way. Unplanned expansion is encroaching the surrounding depression areas, flood plains, retention

areas of Dhaka by land filling. The encroachment of low lying areas all around Dhaka has been carried out by the private real state land developers since 1980s (Islam, 2008). The rate of conversion of wetlands is becoming high in the very recent years. Thus, the recent trend of development in Dhaka has become an alarming threat for the existence of its wetlands. Since wetlands form an important component of the environment due to their biological, ecological, economic, social and cultural values (Ramachandra et al., 2005).

Under such situation, the research would address the following implications in making policies for the conservation of wetland of Dhaka:

(a) Yearly Return from Conserving Wetland

Traditionally conserved wetlands are considered by many to be of little or no value or even at times to be of negative value in all over the world (Turner et al., 2003). But if wetlands are conserved properly they provide a range of valuable ecosystem services and goods. As most of these services and goods are difficult to quantify and document by policy makers and general public their conservation issue is often neglected. That means to determine the economic benefits of a wetland is the first step in formulating any wetland conservation plan. This research will help the policy makers to clearly understand the yearly economic benefit that can be earned from a conserved wetland in Dhaka at instant.

(b) Agriculture in Wetland and Food Security

In Dhaka, the rivers and their adjacent flood plains are flooded during monsoon. Flooding enhance biological activities in flood plains as it deposits silt as topsoil which is rich in nutrients like phosphorous, potash, nitrogen and thus increase the soil fertility (Islam, 2008). This natural process of fertilization has great impact on agricultural productivity in flood plains. Hence, wetland has high agricultural value and production of crops particularly paddy in these fertile lands in dry season is quite satisfactory which is also revealed from this research. During wet season, the wetland merges with the adjacent river and abundant with fishes. Local people

cultivate varieties of fishes which are very much productive and thus it acts as a supportive source of income.

Rapid population growth in Dhaka has created severe pressure on the land. A large number of poor people are migrating to Dhaka daily in search of employment and other facilities and thus contributing to rapid growth of poverty in the city. Agricultural lands are converted to housing developments, roads and other infrastructure facilities. Thus, with rapid and unplanned urbanization, incidence of urban poverty and food insecurity has increasing at an alarming rate in Dhaka (Choguil, 1995 cited in Islam, 2002). Under such situation, urban agriculture and fisheries can contribute a lot to food security by increasing the supply of food and also by enhancing the quality of perishable foods by quickly reaching to urban consumers.

Conserving wetland for producing agriculture in dry season and fisheries in wet season can be an effective method in ensuring food supply and satisfying nutritional needs of the inhabitants. If government thinks about the policies regarding the proper management of wetland, then such prospects should be considered. This research has shown that both the production of paddy and fisheries in wetland are beneficial and very much interconnected to the overall livelihood and economy of the local people as well as the city dwellers.

(c) Prospects of Wetland as Recreational Site

During wet season, wetland becomes a place of attraction for the city dwellers. People mostly enjoy the scenic beauty and boating in this season. In urban life being confined within the concrete structure people can rarely get places and chance to enjoy the beauty of the countryside. Wetland provides them such opportunity of enjoyment. If government takes initiatives to conserve wetland and to properly plan and design it to flourish as a recreational site, it must calculate the yearly return from these lands as a recreational site. This research would provide a backdrop in this purpose.

(d) Importance of Wetland in Climate Change Scenario

Climate change will affect Dhaka primarily in two ways- through floods and heat stress. The melting of glaciers and snow in the Himalaya and erratic changes in temperature and rainfall will lead to more frequent flooding. The water logging and drainage congestion due to river floods and excessive rainfall during monsoon are already causing very serious damage (Alam and Rabbani, 2007). It is very difficult for a rapidly growing urbanized area to manage such heavy rainfall within a short duration.

Adaptation is the way to address climate change impacts. Wetland conservation as detention area is one of the adaptation measures. That is why conservation of low lying areas, retention ponds and flood plains for accommodating excessive water is a burning issue to response against climate change impacts. To justify the conservation issue of wetland and to address the devastating consequences of climate change as well as flood and heat, government has to evaluate the yearly flood loss and this research would assist that purpose.

(e) Justification of Conserving Wetland instead of Conversion

In Dhaka where the rate of urbanization is high and development force is dominant, the battle to protect wetland may face the toughest job. Here the undeveloped land is very much scarce and valuable commodity. A private landowner may claim that he earn higher returns by converting wetland for residential, commercial or other development purposes rather conserving it. It is because of the fact that a large number of ecological functions and important services provided by wetland to society such as storm protection, flood control, disaster prevention, nutrient retention, micro-climate stabilization are neither sold nor have market price. Therefore, private land owners do not receive any return for these ecological functions on preserving wetland, even though the wetland provide valuable services to the society. Development or conversion of the wetland produce marketable outputs whereas maintain a wetland in a natural state leads to the preservation of marketable as well as a large number of non-marketable goods and services (Barbier et al., 1997).

From social point of view, the benefits of conserving wetland must outweigh the value of development benefit. Moreover, development benefits are not renewable but wetland benefits are renewable. Conserving wetland is a moral obligation as its existence is very much essential for the survival of urban life. Wetland in Dhaka must be conserved if the short term as well as long term benefits of wetland is considered. The long term benefits include providing of food security and water supply, preventing from climate change and flood, maintaining ecosystem and other such functions. To ensure the sustainable management of wetland, policies should be formulated in addressing these facts.

(f) Issue of Compensation in Wetland Conservation

Even though the enactment of the Water Body Conservation Act 2000, the land filling activities mostly in flood plains demarcated by Detailed Area Plan are still continuing by private land development companies (Islam, 2008). This type of conversion is very much detrimental to the overall environment and ecology of the city. Thus, the conservation of wetland has become a crucial issue for the city. To protect the remaining stock of wetland if the government decides to acquire the demarcated wetlands, then it must pay compensation or other form of tax benefits incentives to the private owners of those lands. At such situation, it would be very obvious to find out the yearly benefits from wetland.

9.4 Conclusion

Today, most planning and development decisions are taken on economic grounds. Economic valuation of wetland represents an important area for a clear understanding about the role of natural systems in economic development. Wetland is complex multifunctional system and thus possesses significant economic value. But globally they are under heavy pressure. The main reason is the lack of awareness of the value of the conserved wetlands and its functions. The current trend of wetland loss leads to many countries to adapt different policies to ensure wetland conservation as well as its sustainable way of use. The quantification of significant values of wetlands is the first step to its sustainable planning and use.

The trend of wetland loss is also continuing at a high pace in Dhaka in recent times. It is a difficult task to justify the protection of wetland of Dhaka, where high person to land ratio puts immense development pressure on land and where market force is dominant. In such case, the economic valuation of wetland will help to understand the benefits of conserved a wetland in monetary terms and will act as a catalyst for wetland conservation in Dhaka. The estimated total benefit of the floodplain of the study area is required to formulate wetland conservation plan. If the government takes any conservation policy it will help to hold a clear idea about the yearly benefit from a conserved wetland as well as the compensation and prioritization procedure. Thus, the economic valuation of the wetland will assist the decision makers to take proper policies and actions regarding its conservation as well as to restrict its subsequent conversion and losses.

Appendix A

Department of Urban and Regional Planning
Bangladesh University of Engineering and Technology (BUET), Dhaka
(All the information collected will be used for academic purpose only)
Questionnaire on

DETERMINING THE RECREATIONAL VALUE OF A WETLAND OF DHAKA

Questionnaire No…….

1. Have you visited here for recreation? Yes No

Socio-Economic Information of Respondent:

Age	Gender	Educational Qualification	Occupation	Individual Expenditure (monthly in tk)	Expenditure on Recreation (monthly in tk)	Place of Living

Gender: Male = 1; Female =2

Educational Qualification: Illiterate = 1; Below S.S.C = 2; S.S.C = 3; H.S.C=4; Graduate = 5; Post-Graduate= 6

Occupation: Government Service= 1; Private Service= 2; Business= 3; Student= 4;
Others……(specify)

2. Have you come to the site alone or in group? Alone In group, If in group, then ……persons

3. How frequently do you visit this site?

   i) Weekly ii) Monthly iii) Half yearly iv) Yearly v) Not Available

4. Frequency of visit in the last year (2010)?.....

5. What is your preferable time of visit to this site?

Season	Day	Time

6. What is your mode of transport to this site?.....

7. How much time it takes to reach this site?.....and you spend on the site……?

8. Information on different costs for visiting to this site (in tk) per person:

Travel cost	Food cost	Parking cost	Boating cost	Entry fee

9. Is there any substitute site for visit Yes No; If yes then number of sites……,
   places……..and cost of visiting sites……tk

10. What are the attractive features of this site?.....

Appendix B

Table B1: Distribution of visitors (in percentage) based on their occupation and educational qualification

Educational Qualification	Percentage	Occupation of the respondent					Total
		Government service	Private service	Business	Student	Others	
Illiterate	% within Educational Qualification	0.0	0.0	66.7	0.0	33.3	100.0
	% within Occupation	0.0	0.0	3.2	0.0	2.2	1.0
	% of Total	0.0	0.0	0.6	0.0	0.3	1.0
Below SSC	% within Educational Qualification	0.0	11.1	33.3	25.0	30.6	100.0
	% within Occupation	0.0	4.9	19.4	9.1	24.4	11.6
	% of Total	0.0	1.3	3.9	2.9	3.5	11.6
SSC	% within Educational Qualification	0.0	5.7	25.7	54.3	14.3	100.0
	% within Occupation	0.0	2.4	14.5	19.2	11.1	11.3
	% of Total	0.0	0.6	2.9	6.1	1.6	11.3
HSC	% within Educational Qualification	0.9	6.4	14.7	65.1	12.8	100.0
	% within Occupation	4.5	8.5	25.8	**71.7**	31.1	35.2
	% of Total	0.3	2.3	5.2	22.9	4.5	35.2
Graduate	% within Educational Qualification	17.1	**52.4**	19.5	0.0	11.0	100.0
	% within Occupation	63.6	52.4	25.8	0.0	20.0	26.5
	% of Total	4.5	13.9	5.2	0.0	2.9	26.5
Post-Graduate	% within Educational Qualification	15.6	**57.8**	15.6	0.0	11.1	100.0
	% within Occupation	31.8	31.7	11.3	0.0	11.1	14.5
	% of Total	2.3	8.4	2.3	0.0	1.6	14.5
Total	% within Educational Qualification	7.1	26.5	20.0	31.9	14.5	100.0
	% within Occupation	100.0	100.0	100.0	100.0	100.0	100.0
	% of Total	7.1	26.5	20.0	31.9	14.5	100.0

Source: Field Survey, July, 2011

Table B2: Distribution of Visitors (in percentage) according to their Time and Cost Incurred to Reach the Site

Travel Time (min)	Travel Cost (Tk)						Total
	0-30	31-60	61-90	91-120	121-150	More than 150	
10-30	**33.2**	11.3	4.5	1.0	0.0	0.0	**50.0**
31-60	10.3	6.1	4.8	2.3	2.6	0.0	26.1
61-90	1.6	2.3	1.9	1.0	3.2	0.3	10.3
91-120	1.0	0.6	3.2	0.3	0.6	0.0	5.8
Above 120	0.0	0.6	3.2	2.9	1.0	0.0	7.7
Total	**46.1**	21.0	17.7	7.4	7.4	0.3	100.0

Source: Field Survey, July, 2011.

Appendix C

Table C1: Correlation Matrix of Different Variables Showing All Possible Co-efficients of Correlation between Them

Variable		V	TC	G	A	E	O	I	ER	MT
V	Pearson Correlation	1	-.165 (**)	-0.026	-0.031	0.039	-0.009	-0.022	0.063	.301 (**)
	Sig. (2-tailed)	.	0.004	0.648	0.581	0.495	0.872	0.695	0.272	0
TC	Pearson Correlation	-.165 (**)	1	.250 (**)	.207 (**)	0.027	-.351 (**)	.621 (**)	.419 (**)	-.286 (**)
	Sig. (2-tailed)	0.004	.	0	0	0.638	0	0	0	0
G	Pearson Correlation	-0.026	.250 (**)	1	.234 (**)	.113 (*)	-.246 (**)	.451 (**)	.270 (**)	-0.05
	Sig. (2-tailed)	0.648	0	.	0	0.047	0	0	0	0.376
A	Pearson Correlation	-0.031	.207 (**)	.234 (**)	1	0.08	-.575 (**)	.427 (**)	.252 (**)	-0.098
	Sig. (2-tailed)	0.581	0	0	.	0.16	0	0	0	0.086
E	Pearson Correlation	0.039	0.027	.113 (*)	0.08	1	-0.101	0.068	-0.005	0.016
	Sig. (2-tailed)	0.495	0.638	0.047	0.16	.	0.077	0.233	0.931	0.785
O	Pearson Correlation	-0.009	-.351 (**)	-.246 (**)	-.575 (**)	-0.101	1	-.507 (**)	-.286 (**)	0.02
	Sig. (2-tailed)	0.872	0	0	0	0.077	.	0	0	0.725
I	Pearson Correlation	-0.022	.621 (**)	.451 (**)	.427 (**)	0.068	-.507 (**)	1	.685 (**)	-0.091
	Sig. (2-tailed)	0.695	0	0	0	0.233	0	.	0	0.11
ER	Pearson Correlation	0.063	.419 (**)	.270 (**)	.252 (**)	-0.005	-.286 (**)	.685 (**)	1	0.004
	Sig. (2-tailed)	0.272	0	0	0	0.931	0	0	.	0.937
MT	Pearson Correlation	.301 (**)	-.286 (**)	-0.05	-0.098	0.016	0.02	-0.091	0.004	1
	Sig. (2-tailed)	0	0	0.376	0.086	0.785	0.725	0.11	0.937	.

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

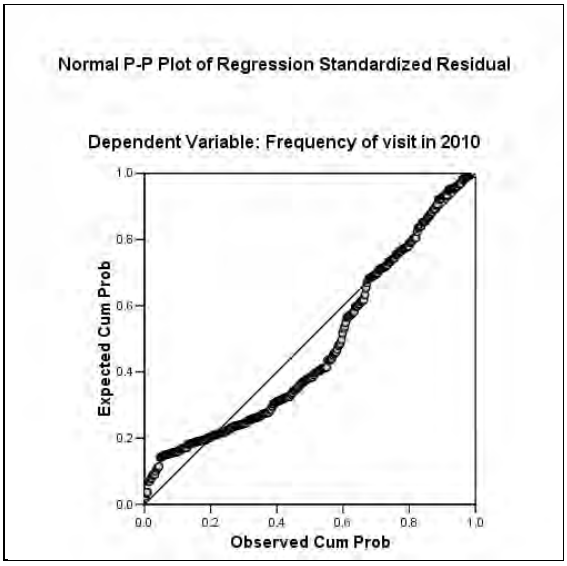


Figure C1: Normal P-P plot of regression standardized residual showing the normality of the distribution

Table C2: The Results of the Co-efficients of Regression Analysis

Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**	**95% Confidence Interval for B**		**Correlations**		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
Ln (V)	(Constant)	1.259	0.344		3.662	0.000	0.582	1.935			
	Travel cost (TC)	-0.001	0.000	-0.319	-4.821	0.000	-0.002	-0.001	-0.329	-0.268	-0.235
	Gender (G)	0.052	0.137	0.021	0.380	0.705	-0.218	0.322	-0.006	0.022	0.019
	Age (A)	0.000	0.010	0.003	0.045	0.964	-0.019	0.020	-0.017	0.003	0.002
	Educational qualification (E)	0.127	0.124	0.051	1.026	0.306	-0.117	0.371	0.060	0.059	0.050
	Occupation (O)	-0.100	0.169	-0.038	-0.592	0.554	-0.433	0.232	0.007	-0.034	-0.029
	Income (I)	0.000	0.000	0.090	1.004	0.316	0.000	0.000	-0.070	0.058	0.049
	Expenditure on recreation (ER)	0.000	0.000	0.058	0.848	0.397	0.000	0.000	0.005	0.049	0.041
	Mode of transport (MT)	1.024	0.137	0.389	7.482	0.000	0.755	1.294	0.471	0.396	0.365

Appendix D

Table D1: Calculation of Total Inundation Area (in acre) During Flood by Uttar Kaundia Mouza

Datum = 3 meter

Sl No.	Elevation (m)	Depth (m)	Avg depth in the area (m)	Area (acre)	Area (m^2)	Volume of retained water (m^3)	1 acre = m^2	Depth of inundation during flood 2007 (m)	Inundation area (m^2)	Inundation area (acre)
1	2.813			150	607050	299730.9	4047	1.5	199820.625	49.375
	2.726	0.274								
	2.782	0.218								
	2.468	0.532								
	2.049	0.951	0.49375							
2	2.743			150	607050	337975.1	4047	1.5	225316.725	55.675
	2.587	0.413								
	2.338	0.662								
	2.328	0.672								
	2.52	0.48	0.55675							
3	2.179			170	687990	722045.5	4047	1.5	481363.67	118.943333
	2.176	0.824								
	1.643	1.357								
	2.05	0.95								
	1.933	1.067	1.0495							
4	2.184			250	1011750	982156.3	4047	1.5	654770.875	161.791667
	1.817	1.183								
	2.157	0.843								
	1.945	1.055								
	2.198	0.802	0.97075							
5	2.547			450	1821150	2565090	4047	1.5	1710059.85	422.55
	2.314	0.686								
	1.565	1.435								
	1.405	1.595								
	1.082	1.918	1.4085							
6	1.854			360	1456920	2120547	4047	1.5	1413698.04	349.32
	1.931	1.069								
	1.047	1.953								
	1.415	1.585								
	1.785	1.215	1.4555							
7	1.389			360	1456920	720082.7	4047	1.5	480055.14	118.62
	2.403	0.597								

	2.419	0.581								
	2.351	0.649								
	2.85	0.15	0.49425							
8	2.505			360	1456920	586774.5	4047	1.5	391183.02	96.66
	2.685	0.315								
	2.857	0.143								
	2.068	0.932								
	2.779	0.221	0.40275							
9	2.255			180	728460	413765.3	4047	1.5	275843.52	68.16
	2.469	0.531								
	2.09	0.91								
	2.177	0.823								
	2.992	0.008	0.568							
10	2.213			130	526110	164146.3	4047	1.5	109430.88	27.04
	2.594	0.406								
	2.874	0.126								
	2.766	0.234								
	2.518	0.482	0.312							
11	2.221			40	161880	173171.1	4047	1.5	115447.42	28.526667
	2.555	0.445								
	1.554	1.446								
	2.164	0.836								
	1.448	1.552	1.06975							
Total				2600	11574420 0	9085485			6056989.77	**1496.662**

Source: BWDB, 2011

Table D2: Calculation of Total Inundation Area (in acre) During Flood by Goran Chatbari Mouza

Datum = 3 meter

Sl No.	Elevation (m)	Depth (m)	Avg depth in the area (m)	Area (acre)	Area (m^2)	Volume of retained water (m^3)	1 acre = m^2	Depth of inundation during flood 2007 (m)	Inundation area (m^2)	Inundation area (acre)
1	1.509	1.491		17	68799	103473.7	4047	1.5	68982.46	17.04533
	1.181	1.819								
	1.545	1.455								
	1.644	1.356								
	1.614	1.386	1.504							
2	2.299	0.701		38	153786	121490.9	4047	1.5	80993.96	20.01333
	2.191	0.809								
	2.178	0.822								
	2.43	0.57								
	2.041	0.959	0.79							
3	2.408	0.592		7	28329	9029.869	4047	1.5	6019.913	1.4875
	2.522	0.478								
	2.783	0.217								
	2.73	0.27								
	2.69	0.31	0.31875							
Total				62	250914	233994.5			155996.3	**38.54617**

Source: BWDB, 2011

Table D3: Electricity Unit and Bill of Different Water Pump Station in Dhaka City

Name of Water Pump Stations	Production of Water (M^3/Month)	Electricity Unit		Electricity Bill in Tk (including PFC charge, Demand charge, VAT)
		Off- Peak	Peak	
Mohammadia Housing Society	138329	26639	7896	167039
Rafiq Housing	174881	39530	12166	274796
Dhaka Udan	83700	16925	8615	84095
Monsurabad	119334	22368	6504	135344
Tikkapara	120014	22892	8032	164613
Iqbal Road	83600	26858	9444	174708

Source: DWASA, 2010 cited in Anwar, 2010

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