CHAPTER 3
CONCEPTUAL AND METHODOLOGICAL FRAMEWORK

3.1 Introduction
The loss of wetland features has serious repercussion on the welfare of the people whose welfare is directly or indirectly dependent on these features. One of the significant non-marketable wetland features is biodiversity which has been drastically lost without much consideration of its economic value and ecological and socio-cultural benefits (Barbier et al. 1997, Verma 2001). Economic value of wetland biodiversity is reflected through the linkages with economic welfare of humans and consumer preferences for biodiversity benefits.

During the past few decades the area of the Deepor Beel has undergone rapid changes due to industrialization, agricultural activities, forest cover change in the adjoining reserved forests and human settlement within the wetland and its buffer zone; resulting in an imbalance in the wetland eco-system. Moreover, the inflow of storm water from Guwahati City to the Beel is degrading its water quality causing a hazardous environment for the aquatic flora and fauna.

In order to avoid further degradation of the Beel and to achieve the socially efficient stock, there is a need for quantification of goods and services provided by the Deepor Beel. Proper quantification is also required for effective policy formulation by the Government.

3.2 Economic Value of the Deepor Beel: A Conceptual Framework

Free access by the resource users to common property resources such as wetlands can lead to excessive exploitation and even extinction of species (Wattage and Mardle 2008). The economic valuation of the environment is based on public perceptions upon ecosystem performance. In this context, it is substantial to first define wetland features that
are important to society. According to Turner et al. (2000), interactions among wetland characteristics, structure and processes result in the performance of functions, are not of economic in nature but provide a flow of goods and services which are valued by society. In case of the Deepor Beel, these values are direct or indirect use of such goods and services (direct use, indirect use values and option value) or are independent of use (non-use values i.e. existence and bequest value). Secondly, the study identified the different resource users of the Deepor Beel, classified them according to the intensity of resource use and determined the relevant sets of prices and costs that settle on the economic trajectories of their production activities and estimated the monetary values (Abraham and Mackie 2006). In cases where resource uses have no observable market, the study conducted a Contingent Valuation survey to elicit economic values of such uses, to various groups of consumers, whether they used or did not use the wetland. The aggregated values of wetland goods and services constitute the Total Economic Value of the Deepor Beel.

At the heart of the debate on use and management of the Deepor Beel lays the question of who constitutes a resource user of the functions provided by the Beel. In the case of complex multi-stakeholder environments like wetlands, a resource user constitutes all those who affect and/or are affected by policies, decisions and actions on the eco-system. They can be individuals, communities, social groups or institutions of any size in the society (Grimble and Chan 1995). Most local users are direct users of wetland resources. Indirect users, on the other hand, are those who benefit from the services indirectly while the non-users are composed of a larger set of population that is concerned with the wetland. In case of the Deepor Beel, same considerations follow.

As mentioned above, the Deepor Beel fresh water eco-system performs various functions. These functions provide a varied set of resources and services to local communities, the benefits of which are derived not only by resource users but by non-users as well. In this study, the functions provided by the Beel are categorised into four main categories. These are:
a) Physical/Hydrological Function
b) Chemical Function
c) Biological Function
d) Socio-Economic Function

The connection between the functions of the Deepor Beel which provide a varied set of resources and services and the various resource users of those resources and their perception of the cost and benefits derived from those resources is depicted with the help of the concept of Total Economic Value (TEV). Figure 3.1 below depicts the framework for estimating the Total Economic Value (TEV) of the Deepor Beel. As indicated, the study first looks at the ecological setting of Deepor Beel. The study tries to find out the link between the functions which provide various goods and services to the people and the resource users of the wetland. These functions provide a varied set of resources and services. Different values of the functions and the preferences, perceptions of resource users towards those values are discussed in the next part. Measurement of these values and the assessment of the users’ perceptions are attempted using environmental economics tools like market based techniques and the Contingent Valuation methods. These valuations ultimately lead to the Total Economic Value (TEV) of the Deepor Beel.
Figure 3.1: Estimation Framework for Total Economic Value of the Deepor Beel

Total Economic Value (TEV) = UV + NUV

- Use Values (UV)
  - Direct use value
    - Fishing etc.
  - Indirect use values
    - Ground water recharge etc.

- Non Use Values (NUV)
  - Option value
  - Bequest, Existing and altruistic value
  - Measuring values

- Perceptions: resource users and non-users perceptions of the values of benefits and costs derived from resources

- Assessing perceptions/values through

- Total Economic Value

Resources:
- Various resources users or stakeholders
  - Direct resource user i.e. paddy farmers, fishermen etc.
  - Indirect resource users i.e. local community
  - Non resource users i.e. world community

Values of the functions/services:
- Physical/Hydrologic function
  - Flood control, sediment retention and nutrient export, mitigating

- Chemical function

- Biological function
  - Fish and other living beings and availability of water

- Socio-economic function
  - Sources of food, fiber, fuel and cultural services

Wetland functions/services:
- Structure
- Deepor Beel
- Boundaries

Market Price Approach for direct use values

Contingent valuation approach for indirect use value, option and non-use values
3.2.1 Identification of the Activities Done in the Deepor Beel Area

An in-depth survey is done to identify the activities performed in and around the Deepor Beel area. It is found in the survey that fishing, paddy cultivation and fodder collection are the major activities done in the Beel area. A large number of local people who belong to the fishing community depend on the Beel. Fishing is the main source of livelihood of these people. A total of 825 families depend directly on fishing. The fish is also the main source of protein of these people.

The paddy cultivation can also be considered a main activity done in the Deepor Beel area. The area around 200-300 bighas\(^1\) of land are used for paddy cultivation.

As most of the local people rear cattle, fodder collection is also considered a major activity done in the Beel area. The people can save a significant amount of money from their monthly expenses from fodder collection. But they get the benefit only for six month of a year due to flood, which remains half of a the year.

The activities like collection of Nymphaea nuts, flowers, etc., and other edible plants cannot be considered as major activities as they don’t provide any kind of livelihood or any major source of income to the local people who depend on the Beel.

3.3 Research Methodology

3.3.1 Sources of Data

Both primary and secondary data are used for the study. In the primary data collection process, calculation of the use and non-use value of the Deepor Beel has been done through a household survey by employing a structured information schedule. Data collection is done for estimation of use and non-use value separately. In case of use value of the wetland, different sample sizes are considered for different resource use. To calculate the value of fishing activity, households engaged in fishing are taken into consideration; while calculating the value of paddy cultivation total area of cultivation and the number of paddy

---

\(^1\) Measurement of land in Assam. 1 bigha = 0.1338 hectare
cultivators are considered. In case of estimation of fodder collection value, appropriate sample procedure and sample size is used. All the primary data were collected in October 2015 to March 2016.

Secondary information are gathered from the sources such as reports from Ramsar website, reports of Ministry of Environment and Forest(MoEF), Government of India reports on Indian Wetlands, MoEF sponsored reports prepared by the Space Application Centre, Indian Space Research Organisation in various years, MoEF sponsored reports prepared by ARSAC, ASTEC etc in various years, reports prepared by Planning Commission of India, various technical reports of reputed national and international organisations such as UNEP, United Nation Development Programme, Aaranyak etc and various reports and publications of individual researchers etc. this information is analysed to construct the background of the study.

3.3.2 Sampling Design and Sample Size to Estimate the Direct Use Value of the Beel

There are five revenue villages located in the precincts of the Deepor Beel. They are namely Pamehi, Mikirpara Chakardo, Lakhara, Lakhra NC and Azara. As per the village headman of Azara revenue village, there are total of 60 households engaged in paddy cultivation. All the information related to the production and sell of paddy cultivation are collected from the Village Headmen of Azara and Mikirpara Chakardo revenue villages. They are given responsibility to administer the various subas of the five revenue villages adjacent to the Beel under 33 No Azara Gaon Panchayat.

In case of fishing, it is known from Resource Inventory of Beel Fishery, 2010\(^2\) that there are a total of 825 households, in various subas\(^3\) of these villages, whose are directly depend on fishing. Stratified random sampling procedure is used in the survey to estimate the value of fishing. First the subas are divided into different strata according to the residents who are involved in fishing as their source of livelihood. The random sampling procedure is then

\(^2\) Resource Inventory of Beel Fishery, 2010 is prepared by the Village Headmen to submit to the respective Revenue Circle Office.

\(^3\) Suba: Households about ten (10) or more in an area consists of 1 suba.
followed to select sample households to conduct the survey. From the 825 fishing households, 20 per cent of the household are taken randomly as samples. A structured information schedule survey is conducted among 165 households. A brief description of the scope and coverage of the study and possible outcomes are explained at the beginning of the interview. To collect the required data, door-to-door survey is carried out. Apart from household survey various secondary information are collected from the Village Headmen.

Information of the fodder collection is gathered during the Contingent Valuation (CV) survey. It is seen from the survey that, 91.7 percent of the surveyed people collect fodder for their cattle from the Deepor Beel. The sample size for fodder collection is therefore 275 as total number of samples of CV survey considered is 300. According to the data submitted to the office of Revenue Circle in the year 2015 by the village headman of Azara, there are 400 household rearing cattle. Therefore, total number of households depend on fodder is 400.

3.3.3 Analytical Methods for Calculation of Direct Use Values

The calculation of economic values crucially depends on the selection of appropriate tools. In this study, market valuation method is used to estimate the gross and net values of those goods and services having direct markets. Activities like fishing, wetland paddy cultivation and fodder collection have formal markets and hence the gross and net revenue produced by the units operating these activities are approximated.

3.3.3.1 Valuation of Paddy Cultivation

1) To estimate the paddy cultivation, three indicators are used: the Gross Financial Value (GFV), the Net Financial Value (NFV) and Cash Income (CI). These values are computed as follows (Olalekan et al. 2008, some equations are modified according to need of the study):

\[ \text{GFV} = \text{TQH} \times P \]

where TQH is the Total Annual Quantity Harvested (or produced) and P is the average price per unit of product at which a resource/commodity is sold in the market. There are
two seasons of cultivation of paddy, i.e. Ravi and Kharif season. The total production of paddy is calculated on the basis of area used for cultivation. Therefore, TQH is computed on the basis of production of paddy on area used for production in both the seasons.

\[ TQH = \sum_{i=1}^{n} QH_i \]

\[ QH_i = \text{Total quantity of paddy produced} \]

\[ i = \text{Ravi and Kharif seasons} \]

\[ NFV = GFV - CST \]

CST is total costs of collection / production, excluding cost of family labour. Costs are estimated based on all monetary inputs going into the harvesting. Tools used for harvesting resources represent the main source of cost. The cost of family labour is not being taken into account as the opportunity cost is considered minimal in a context of low earning skills.

Finally, the Cash Income (CI) is the monetary value of quantity sold which is calculated by:

\[ CI = QPS \times P \]

where QPS is the total quantity of product sold. It is estimated by the amount of paddy sold in the market in both the seasons by the paddy growers.

\[ QPS = \sum_{i=1}^{n} AACU_i \times TH \]

AACU= Average amount left for commercial use

TH=Total number of households

\[ i = \text{Ravi and Kharif seasons} \]
3.3.3.2 Valuation of Fishing

2) For valuing the fishing activity, net monetary benefits from commercial fishing is estimated with the help of the following expression

\[ F = \sum_i V_i - [n+e+b+m] \]

where,

- \( F \) = Net monetary annual benefits from fish catch from the wetland
- \( V_i \) = monetary value of the fish caught (annual value)
- \( n \) = cost of net used per year
- \( e \) = cost of equipments used to keep caught fish per year
- \( b \) = cost of boats per year
- \( m \) = cost of maintenance of boats per year
- \( n+e+b+m \) = total cost involve in fishing activities

3.3.3.3 Valuation of Fodder Collection

Fodder collection benefit is estimated through the cost of procurement of the amounts of fodder provided by wetlands. Total quantity of fodder needed per year is estimated and then its market value is calculated. This method is popularly known as indirect substitute cost method. This amount is considered as the amount saved by the people per month due to the collection of fodder by them from the Beel. Otherwise, the same amount they had to spend extra to buy fodder for their cattle. However, this is applicable to those households who collect fodder from the Beel.

Formula for Fodder collection for a month is

\[ FCB = NH \times AMS \]

where,

- \( FCB \) = Fodder collection Benefit,
- \( NH \) = number of household extract fodder from the Beel
- \( AMS \) = amount of rupees saved per month.
Assuming that there is a linear relationship between the area of wetland that contributes to a certain wetland good or service and the use value delivered by that function, the relationship of total use value of direct benefits from the Deepor Beel can be expressed as follows:

\[
TUV_{\text{for direct use}} = \sum NV_i
\]

Where,

- \(TUV\) = Total Use Value
- \(NV\) = Net value of the product derived from wetland
- \(i\) = Wetland activities (paddy cultivation, fishing and fodder collection)

### 3.3.4 Sampling Procedure and Sample Size to Estimate the Indirect and Non-Use Values of the Beel

Contingent Valuation Method (CVM) for household survey is intended to gather information on Willingness-To-Pay (WTP) for conservation and management of the Deepor Beel from the head of the households or adult respondents who has attained the age of twenty years and above. The Willingness-To-Pay (WTP) for conservation and management of the Deepor Beel is based on the functions the Deepor Beel performs. For any survey-based study, recognition of the target population is the first task after setting the background of the study. The most important part while deciding a target population for a CV study should be based on the fact that who will be benefited / affected from any change in the environmental service directly or indirectly (Bateman et al. 2002). As the present study aims to estimate non-use value or conservation value of the Deepor Beel, it would be more appropriate to set the target population for sampling.

From the above discussion, the study cautiously restricted the target population to the area surrounding the wetland within 1 kilometer from the periphery of the Deepor Beel. All people living in this stretch of land would most likely be affected as a consequence of conservation of the land for development. This section of people is immediately threatened
from developmental activities and the most to gain from conservation. Although those who are living relatively close to the Deepor Beel would be affected immediately by any developments, the impact of total benefits may be more widespread. Due to the time and resource constraints, the present study is restricted mainly to the 5 (five) revenue villages adjacent to the Beel. According to Census 2011, the total number of households in these 5 villages is 3046. The double-staged random sampling procedure is used for collecting the household primary data. The study area is first classified on the basis of territorial dissection touching the wetland border along different directions. It is known that there are five villages which are adjacent to the Beel area. From each village, 10 per cent of the total households are selected as samples. Total households (THH) samples are found to be 305 for the study. In the pilot survey, it is found that the characteristics of the households are similar. Therefore simple random sampling procedure is used to collect the unit data. Detailed survey procedure is depicted with the help of the figure 3.2 as given below:

**Figure 3.2: Sampling procedure and sample size for Conservation Valuation of the Deepor Beel**

Out of the 305 samples, 5 are found as protest and zero bid, therefore only 300 samples can be used for the study.
3.3.5 Survey Design for Contingent Valuation (CV) Method

The CV survey for the valuation of wetland functions is conducted using a carefully designed information schedule, following the National Oceanic and Atmospheric Administration (NOAA) panel’s guidelines. The final version of the information schedule is formulated after a pilot survey. The information schedule consists of four parts (Mitchell and Carson 1989), of which the first part deals with general questions, the second part presents respondent’s environmental attitude and perception, third part deals with WTP questions and the fourth includes respondents’ socio-economic characteristics. The first part tries to get information regarding head of the households, total adult and females of the households etc. Information about the household infrastructure and household access to basic amenities and household assets are also collected from the first part. In the second part, questions are put to gather information about the environment attitude and perception of the respondents. In the third part, an introductory text explaining the purpose of the survey is provided and presented the scenario for the restoration and conservation of the functions and then asked about their WTP for the conservation programme to protect the Beel. Functions are described to the respondents. Information about the functions involve all relevant goods and services, the situation of non-provision of goods and services due to loss of functions and of functional performance which corresponds to the conservation scenario. The information schedule includes four WTP questions; the first three concern WTP for separate functions and the last WTP for all functions. As the activities done under socio-economic function is evaluated with the help of direct use valuation methods, therefore first three functions are considered in indirect and non-use valuation method, i.e. CV method. Successive valuation of assets is subject to question order bias (Carson and Mitchell 1995), connected mainly to substitution and income effects. To avoid such bias, the order of WTP questions for separate functions is asked in different sequence across household survey. In each question, respondents are asked to place a value on a function, regardless payments for other functions. Furthermore, respondents are reminded that such payments may constrain their annual incomes. The payment vehicle is a monthly amount of money to be collected for Beel conservation and restoration programme which comes under municipal taxes. Taxation is incentive-compatible for referendum votes (Mitchell and Carson 1989) and it minimizes ‘‘warm glow’’ effects (Kahneman and Knetsch 1992).
This procedure simulates real-life provision of public goods and it is applicable to non-use values (Burgess et al. 2000). A tax of local interest, in particular, ensures respondents that their money is directed towards their local community and is not scattered through bureaucracy. The WTP question is preceded by a payment principle, where respondents are asked if they are willing to pay any amount for the conservation of a wetland function. A follow-up question to “no” answers is aimed at identifying protest votes. A “yes” answer is followed by a Discrete-Choice (DC) WTP question. This imitates consumers’ decision-making process for real-world transactions and reduces strategic behaviour (Hoehn and Randall 1987). Careful bid selection is of crucial importance for this question format. In this study, bids are determined based on the results of the pilot survey.

The final section of the CV information schedule is concentrated to understand respondent’s socio-economic information which helps a researcher to analyse the results properly. In this part, information about the respondents’ age, gender, occupation, income, savings, education, years of living near the Beel are gathered. According to Hammit et al. (2001), an economic value of a wetland is the function of the wetland systems ecological uniqueness and their socio-economic situation. This value also depends on location and other attributes. For a CV study socio-economic variables such as age, gender, sex, level of education, occupation of the respondents, size of the respondents’ family, level of family income, etc. play very crucial roles in determining people’s Willingness-To-Pay (WTP) or Willingness-To-Accept (WTA) for a particular environmental resource. Therefore, questions related to respondents’ socio-economic and demographic information are thus designed in the information schedule to understand these characteristics of the respondents which could help to analyse their responses regarding their WTP for conservation and management of wetland biodiversity more accurately.

3.3.6 Analytical Methods for Estimation of Indirect and Non-Use Values of the Beel

The calculation of the conservation value is based on the wetland functions of the Deepor Beel perform. These functions create benefits to the beneficiaries. The performance of these functions depends on a range of factors such as the type and the site of the wetland, its substratum, the origin, depth and chemical composition of the water, vegetation types,
diversity of habitats, etc. The functions and the goods and services provided by the Deepor Beel are presented below.

a) Physical / Hydrological Function: The wetland is the main provider of flood attenuation potential in inland water systems. It generates an extensive range of indirect benefits through sediment trapping, water recharge and storage, nutrient cycling and water decontamination functions.

Flood control function is the short-or long-term detention and storage of waters from overbank flooding and/or slope runoff and their gradual release, so as to reduce peak flow. Flood and corrosion control is of value for protected assets and resources.

Sediment retention function involves the net retention of sediments (nutrients, heavy metals or agrochemical residues), carried in suspension by slowly moving waters inundating the wetland, by runoff from the contributory area, by precipitation and/or by the wind. The main service of this function is water quality maintenance, which constitutes a natural substitute for water purification facilities, generates recreational activity, preserves fish stocks and is important for health of the local people. This function also includes mitigation of damage of water conveyance facilities and soil enrichment with nutrients, unless fertility is decreased by silt deposition.

Nutrient export function is the removal and/or transformation of excess nutrients (nitrogen and phosphorus) from a wetland via biological, biochemical, physical and land management processes. Excessive nutrient concentration accelerates eutrophication, which is the cause of turbidity and oxygen deficiency. The predominance of such conditions entails increased vegetation, reed bed expansion, loss of habitats and of biodiversity, including commercial fisheries, unsuitable water for consumption and decrease in amenity value.

b) Chemical Function: Under this function, a groundwater recharge is considered. This involves the recharge of groundwater by infiltration and percolation of detained floodwater into a significant aquifer. Groundwater is endowed with existence, option and bequest
values, while its actual uses include provision of household water, irrigation, livestock and wildlife watering through surface water supplies.

c) **Biological Function:** The Deepor Beel provides two important services such as fish supply, other flora and fauna and water availability affecting human well-being. The fishing in the Beel is the primary source of protein to the rural communities living near the Beel. The Beel is rich for its diverse range of flora and fauna. The water of the Beel is used mainly for irrigation. The animals of the reserve forest and of the nearby area, various local and migratory birds also depend on the water of the Beel.

d) **Socio-Economic Function:** This involves food web which includes the support of food webs within and outside the wetland through the production of biomass and its subsequent accumulation and export. The wetland area is used for cultivation of paddy, fishing and fodder collection of the cattle, which have significant economic importance. The wetland also provides significant aesthetic, educational, scientific, artistic and religious benefits, as well as a vast array of prospects for recreation and tourism.

As stated earlier, Contingent Valuation Method (CVM) is used to estimate the conservation value of the indirect and non use values provided by the Beel through these functions. The last function is not considered in CVM method as goods and services provided by the wetland are estimated under the direct use valuation methods.

### 3.3.7 Model Specification

Model specification is the determination of independent variables which should be included in or excluded from a regression equation. The specification of a regression model should be based on theoretical consideration (Allen 1997). In this study, analysis of CV data is based on the construction of a statistical model with utility-theoretic considerations (Hanemann 1984, 1989). To measure the welfare, Willingness-To-Pay (WTP) has been estimated.
3.3.7.1 Theoretical Consideration

Let’s consider the response \( y_i \), to the WTP for conservation of the Beel, is binary, assuming only two values that for convenience we code as 1 or 0. For example, it can be defined as

\[
y_i = \begin{cases} 
1 & \text{if the } i\text{-th response is yes} \\
0 & \text{otherwise.} 
\end{cases}
\]

It is assumed that \( y_i \) as a realization of a random variable \( Y_i \) that can take the values 1 and 0 with probabilities \( \pi_i \) and \( 1 - \pi_i \) respectively. The distribution of \( Y_i \) is called a Bernoulli distribution with parameter \( \pi_i \), and can be written in compact form as (Rodriguez 2007)

\[
\Pr\{Y_i = y_i\} = \pi_i^{y_i} (1-\pi_i)^{1-y_i},
\]

for \( y_i = 0, 1 \). Note that if \( y_i = 1 \) we obtain \( \pi_i \), and if \( y_i = 0 \) we obtain \( 1 - \pi_i \).

It is fairly easy to verify by direct calculation that the expected value and variance of \( Y_i \) are

\[
E(Y_i) = \mu_i = \pi_i, \quad \text{and} \quad \text{var}(Y_i) = \sigma^2 = \pi_i(1-\pi_i).
\]

Note that the mean and variance depend on the underlying probability \( \pi_i \). Any factor that affects the probability will alter not just the mean but also the variance of the observations. This suggests that a linear model that allows the predictors to affect the mean but assumes that the variance is constant will not be adequate for the analysis of binary data.

The Logit Transformation

The next step is defining a model for gathered data. It is assumed that probabilities \( \pi_i \) depend on a vector of observed covariates \( x_i \). The simplest idea would be to let \( \pi_i \) be a linear function of the covariates, say

\[
\pi_i = x_i^T \beta.
\]

where \( \beta \) is a vector of regression coefficients. Model 3.3 is sometimes called the linear probability model. This model is often estimated from individual data using ordinary least squares (OLS).
One problem with this model is that the probability $\pi_i$ on the left-hand-side has to be between zero and one, but the linear predictor $x_i\beta$, on the right-hand-side can take any real value, so there is no guarantee that the predicted values will be in the correct range unless complex restrictions are imposed on the coefficients.

A simple solution to this problem is to transform the probability to remove the range restrictions, and model the transformation as a linear function of the covariates. It can be done in two steps.

First, move the probability $\pi_i$ to the odds

$$\text{odds}_i = \frac{\pi_i}{1-\pi_i}$$

defined as the ratio of the probability to its complement, or the ratio of favorable to unfavorable cases. If the probability of an event is a half, the odds are one-to-one or even. If the probability is 1/3, the odds are one-to-two. If the probability is very small, the odds are said to be long.

Second, take logarithms, calculating the logit or log-odds

$$\eta_i = \logit (\pi_i) = \log \left( \frac{\pi_i}{1-\pi_i} \right)$$

(3.4)

To see this point note that as the probability goes down to zero the odds approach zero and the logit approaches $-\infty$. At the other extreme, as the probability approaches one the odds approach $+\infty$ and so does the logit. Thus, logits map probabilities from the range (0, 1) to the entire real line.

Solving for $\pi_i$ in Equation 3.4 gives

$$\pi_i = \logit^{-1} (\eta_i) = \frac{(e^{\eta_i})}{1 + e^{\eta_i}}$$

(3.5)

We are now in a position to define the logistic regression model, by assuming that the logit of the probability $\pi_i$, rather than the probability itself, follows a linear model.
The logit model for this study is based on the above consideration. It depicts a dependent variable which shows the probability that a respondent accepts the payment of a certain bid, and the independent variables are the bid amount and the respondent’s socio-economic characteristics.

\[
\log \left( \frac{P(\text{Yes})}{1 - P(\text{Yes})} \right) = B_0 + B_1(Bid) + B_2(Age) + B_3(Gender) + B_4(Education) + B_5(Income) + B_6(Resident)
\]

where \( P(\text{‘‘Yes’’}) \) and \( [1 - P(\text{‘‘Yes’’})] \) are the probabilities that a respondent accepts or rejects the payment of a certain bid, respectively.

The independent variables and their expected signs are discussed below:

- \( B_0 \) is the intercept term, and \( B_1, B_2, B_3, B_4, B_5, B_6 \) are the variable coefficients.

- Bid is the bid amount. It is expected that respondents reject a payment as it gets higher, therefore the expected sign of the co-efficient is (-).

- The expected sign of the co-efficient of variable age is (+), as indicated by Nunes and Schokkaert (2003).

- Gender is a nominal variable. There are no a priori indications for its expected sign (Teal and Loomis 2000).

- Education - number of years the respondent has received education.

- Income - here it is expected that lower income respondents are less likely to accept the payment of a certain bid than respondents with higher incomes. The expected sign is (+). This is consistent with rational consumer behaviour and income constraints.

- Years of living - Years of living of the respondents of that locality. A positive sign is expected, as locals, who are living near the Beel for years, are direct users of the wetland and they want to pay more for the conservation of the Beel.

Nuva et al. (2009) in their work used logit model to determine WTP of the visitors towards the use of the ecotourism resources of Gunung Gede Pangrango National Park, West Java,
Indonesia. In the logit model, the socioeconomic variables used are age, gender, residential area, marital status, education level, occupation and income.

Akwetaireho and Getzner (2010) conducted a study on livelihood dependence on ecosystem services of local residents: a case study from Mabamba Bay wetlands (Lake Victoria, Uganda), where they study the WTP and WTA of conservation strategies. In this study they use gender, mean age, occupation, annual income, education of the respondents, household size as the explanatory variables.

Multicollinearity test has been done to check whether there are high correlations among predictor variables. The tests are done for each independent variable with the other independent variables and results show the VIF value less than 3 in each case. VIF value equals to 3 is the threshold to check multicollinearity. All the statistical calculations are done with SPSS version 16.

**Justification of considering the independent variables used in the model**

The above mentioned socio-economic variables are found to be significant in pilot survey data. They are significant at 5 per cent level. The same significant variables are considered for the final logit model.

The outcome of the estimation of logit models can be used to generate welfare measures. An attempt has been made to calculate the mean WTP. Using the above logit models, the mean of the non-negative WTP random variable is calculated using the following formula provided by Hanemann (1989):

\[
\text{Mean WTP} = \frac{1}{B_1} \ln(1 + e^{B_0})
\]

where \( B_1 \) is the co-efficient estimate on the bid amount and \( B_0 \) is either the estimated constant (if no other independent variables are included) or the grand constant calculated as the sum of the intercept term plus the sum of products of the mean values of all variables other than ‘‘Bid’’ times their respective coefficients. This formula is also used by Ragkos et al. (2006) to value the Zazari–Cheimaditida wetland and by Loomis et. al. (2000) while measuring the Total Economic Value of restoring eco-system services in an impaired river basin.
The Total Economic Value for indirect and non-use activities of the Beel is estimated by the mean WTP for all functions multiplied by the total population of villages adjacent to the Beel. The meaning of considering those populations is that any development activity performs in the wetland will directly affect the population.

In case of Total economic Value, the same assumption can be considered which is explained above in case Total Use Value (TUV) that there is a linear relationship between the area of wetland that contributes to a certain wetland good or service and the values delivered by that function, the relationship of Total Economic Value (TEV) of the Deepor Beel can be expressed as follows:

\[ TEV = \sum NV_i \]

Where,

- \( TEV \) = Total Economic Value
- \( NV \) = Value of goods and services provided by the Deepor Beel
- \( i \) = Direct Use Values, Indirect and Non Use values

3.4 Estimation of Net Present Value for Use Values and Non-Use Values of the Deepor Beel

Net Present Value is an economic term representing the total economic value of a natural resource item over time (benefits less costs), discounted to present day terms. If we think of the services provided by the Deepor Beel as a stream of annual “income,” then the Beel can be considered as part of Guwahati’s total natural capital. To quantify the value of that capital, we must convert the stream of benefits from the future flows of ecosystem services into a Net Present Value (NPV). This conversion requires some form of discounting. Discounting of the flow of services from natural assets is somewhat controversial (Azar and Sterner 1996). The simplest case involves assuming a constant flow of services into the indefinite future and a constant discount rate.
Under these special conditions, the NPV of the asset is the value of the annual flow divided by the discount rate. Wetland benefits are often expressed as a yearly flow of money. If this yearly flow is expected to continue indefinitely, there is an easy formula for the relationship between NPV and yearly flow:

\[ \text{NPV} = \frac{\text{yearly flow}}{\text{discount rate}} \]

Determination of an appropriate discount rate is a key component in any NPV analysis. A social rate of discount is used to evaluate the impact of management options on intergenerational welfare. The maintenance of future welfare can be regarded as a public good which private individuals will tend to underestimate. The social discount rate is always used in governmental benefit cost analysis. From the existing literature it is found that government discount rate can be set on latest rate of borrowing (Kerry et al. 2008). In this study also social discount rate is considered. The bank rate of that period was considered for the study.

The estimation of Net Present Values for both direct use and indirect and non use of the Deepor Beel are presented in the chapter 6 and 7. The appropriate discount rates for both the uses are discussed in their respective chapters.

In Net Present Value for infinite time period considers the intergenerational efficiency purpose. This actually motivates the development planners for conservation rather conversion of the Deepor Beel.

Stuip et al. (2002), conducted a study on socio-economics of wetlands where they include case studies from developing countries that addressed different wetlands types and values. In case of Mirja Zerga wetland of Morocco, NPV for agriculture was estimated considering the infinite time period. The estimated value of NPV for agriculture was 33 million US $ at 6 per cent discount rate.
3.5 Conclusion

A detailed explanation on the conceptual framework of the study has been provided in the chapter. Various functions of the Beel are discussed which provides the goods and services to the users. The link between the value of these services provided by the Beel and the perception of the users are assessed. On the basis of the framework, proper methodological structure is framed to estimate the values for the different direct, indirect and non-use benefits/services provided by the Deepor Beel. The chapter also tried to throw some light on the economic rationale that influences the organisation of different livelihood activities on this eco-system and value generated from it.