

## Economic valuation of wetland products and services: A case study of Sone Beel, India

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Wetlands provide the world's most productive products and services (PAS) for economic purposes. Wetlands are important for fishing, agriculture, biodiversity, and recreational activities. The present paper attempts to estimate the total economic value of the use and nonuse values of the Sone Beel, the largest wetland of Assam. The fishing communities of the Sone Beel area have been associated with the wetland for generations, and they depend on the wetland for their livelihood. We have adopted the market price method, travel cost method, and contingent valuation method for the economic valuation of Sone Beel. The total economic value (TEV) of Sone Beel is estimated as Rs 561,088,074 (USD 6,769,140.46) per annum, with fishing as the main contributor, whose value is estimated at around 84.53 per cent of the TEV of the wetland, followed by duck rearing, water transport, tourism, paddy cultivation, biodiversity conservation, and future use.

**Keywords:** Contingent valuation method, Economic valuation, Market price method, Nonuse values, Sone beel, Travel cost method, Use values

### Introduction

Wetlands offer economically useful products and services (PAS) to the people<sup>1</sup> who live in and near them<sup>2</sup>. Though human beings benefit from the PAS of wetlands because of their sustainable livelihood, they are undervalued. Undervaluation of the PAS of wetlands is the leading cause of degradation and loss of wetlands. The loss or degradation of wetlands can lead to a decline in key functions such as biodiversity support, water quality improvement, flood abatement, and carbon sequestration<sup>3</sup>. In such a situation, Ramsar Convention, signed in 1971 in Ramsar (Iran), provides insight into the main threats of wetland degradation. The Ramsar Convention is the sole global treaty that explicitly addresses wetlands and provides a framework for national and international efforts to conserve and wisely use wetlands. As stated in Article 1.1 of the Ramsar Convention, 1971, wetlands are defined as "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters<sup>4</sup>." An economic valuation can be used as a tool

to curb the menace of wetland degradation. This is an effort to put quantitative norms to PAS offered by environmental capital, whether market prices are available or not<sup>5</sup>.

The latest inventory of Indian wetlands prepared by the Space Applications Centre (Indian Space Research Organization) is the National Wetland Atlas 2011, and a total of 201,503 wetlands were identified and mapped on a 1:50,000 scale. India contains various types of water resources, including rivers, streams, and coastal regions, with over 757,060 wetlands covering nearly 15.26 million hectares of land, accounting for approximately 4.63 per cent of the country's total geographical area<sup>6</sup>.

The overall wetland area of Assam, northeast India, is estimated to be 764,372 hectares or around 9.74 per cent of the geographical area<sup>7</sup>. According to the Indian Space Research Organization, 11,178 wetlands encompass all types of wetlands, such as rivers, lakes, ponds, and others. Among these wetlands in Assam, only Deepor Beel is enlisted as a Ramsar site wetlands for international importance.

In India, various studies on the economic valuation of some important wetlands have been conducted so far. In her study on Bhoj wetlands in Bhopal, Verma used the production function approach, hedonic

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pricing, and contingent valuation<sup>8</sup>; Abraham, in his study on the Cochin wetland ecosystem, used contingent valuation<sup>9</sup>. Mamatha, in her study on Kolleru Lake in Andhra Pradesh, used contingent valuation<sup>10</sup>; Binilkumar, in his study on Kol wetland in Kerala, used contingent valuation and choice experiment<sup>11</sup>. In his study on Vellayani Lake of Kerala, Vijayan used market price, travel cost, and contingent valuation<sup>12</sup>; Dutta, in her study on Deepor Beel of Assam, used contingent valuation<sup>13</sup>. Kumar *et al.*, in their paper on Sone Beel used revealed preference, cost-based approach, stated preferences, and benefits transfer<sup>14</sup>. Their valuation's primary aim and objective was to provide useful information inputs to the wetland governance to sustain wetlands for multiple benefits. They adopted TEEB (2010) and TEEB (2011) for their valuation of Sone Beel. According to the study, Sone Beel was worth a minimum of USD 88 per hectare per year and a maximum of USD 29,716 per hectare per year in terms of money<sup>14</sup>. Amarayil *et al.*, in their study, used the choice experiment method for the ecosystem values of Loktak Lake in Manipur<sup>15</sup>.

Kar *et al.* described in detail the physio-chemical, biological, and geographical characteristics of Sone Beel<sup>16</sup>. In their study of the fish diversity in Sone Beel, Ngasepam *et al.* found 61 species of fish from 41 genera, 24 families, and 7 orders<sup>17</sup>. Das and Bhattacharjee attempted to focus on the Sone Beel's deterioration and the people's adaptability to it<sup>18</sup>. Roy and Mazumdar investigated the technical efficiency of fish catch and the socio-economic factors that influence it among fishermen<sup>19</sup>. Dutta *et al.* also conducted a study to improve the water level management of Sone Beel<sup>20</sup>.

From the existing limited literature, it is observed that several studies on flora and fauna, water quality, socio-economic status, etc. on Sone Beel have been done. However, the authors have not found any study of the Total Economic Value (TEV) of Sone Beel, which is essential to understanding its sustainability, maintenance, and conservation from the economic perspectives in the present scenario. Keeping this in mind, the present study tries to consider the monetary values of Sone Beel. This paper aims to estimate the TEV of the use and nonuse values of the PAS of Sone Beel.

Estimating the TEV of the PAS of Sone Beel may help the stakeholders and policymakers understand the importance and real value of the wetland for

sustainable use, maintenance, and conservation. Accordingly, this study will reduce the information gap between stockholders and policymakers regarding the various values of the wetlands for maintaining, conserving, and sustainable development of Sone Beel.

## Study Area

### Sone Beel wetland

Sone Beel is located in the Karimganj district of Assam between 24°40'00" north latitude and 92°26'10" east longitude, covering a total area of 3458.12 hectares (Fig. 1). The wetland is fed by the major inlet Singla River, and the outflow of the wetland is the Kachua River<sup>21</sup>. The PAS of Sone Beel extends various economic conveniences to the surrounding people. The Assam government submitted a proposal to declare this wetland as a Ramsar site and confess its nationwide and worldwide value because of its important role in the economic, cultural, ecological, and social lives of the entire region<sup>7</sup>. According to the Secretary of the Sone Beel Fishermen Co-operative Society Ltd. (SBFCS Ltd.), about 5,334 households depend on Sone Beel. The official report of Karimganj Zila Parishad shows that approximately 500 families are employed in net-making and fish marketing activities. Approximately 500 conventional boats ply ordinarily daily. On average, 300 households fully depend on the earnings from the boat services for six months<sup>22</sup>.

Sone Beel is the largest wetland of Assam. Fishing, agriculture, and tourism are economically crucial resources as people living near the wetland directly or indirectly rely on the wetland for their livelihood. Sone Beel is an example of environmental degradation and the livelihood issues encountered by the neighbouring fishermen. Degradation in water quality, qualitative changes in the physio-chemical environment of the water, and depletion in the number and quality of aquatic life of the Sone Beel have all been observed<sup>18</sup>. Numerous flora and fauna are becoming extinct due to the changing ecological conditions<sup>18</sup>. Sone Beel has been confronted with the hard reality of wetland deterioration due to human and other causes producing siltation, drying up of wetlands, and biodiversity loss<sup>18</sup>. This happens due to the lack of consistency in government policies governing the economy, the environment, conservation of nature, and development planning<sup>23</sup>.

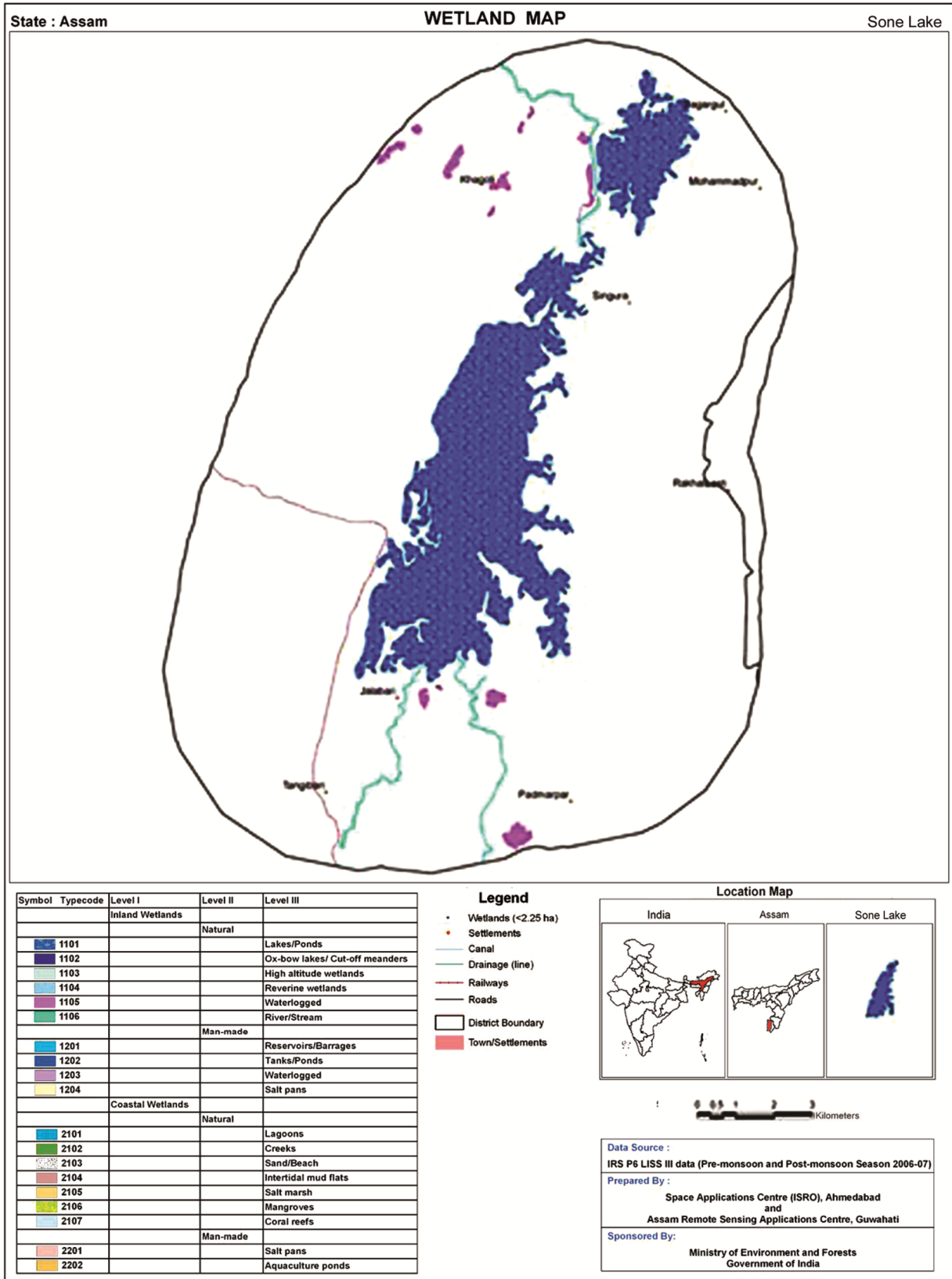


Fig. 1 — Sone Beel, Source — National Wetland Atlas Assam, 2010.

The main causes of wetland degradation are inadequate governance and management. The major threats to this wetland that were identified are agriculture, excessive fishing, and hunting of migratory birds<sup>7</sup>. Sone Beel's depth has been becoming shallower every day<sup>18</sup>. The primary reason is siltation, garbage dumping, and sewage disposal in the wetland. Excessive fishing activities disturb the wetland biodiversity<sup>7</sup>.

## Materials and Methods

### Analytical framework

The study relied on the total economic valuation assessment approach to identify the values of the resources of Sone Beel. Total economic valuation is a widely recognized and valuable framework for valuing ecosystem PAS. Ecosystem PAS are classified based on their usage, using the total

economic valuation approach. It consists of marketable and non-marketable benefits. This approach divides TEV into two categories, viz., use value and nonuse value, which are determined by the benefits received by present and future generations. On the other hand, use values are divided into direct and indirect use values. The steps followed for total economic valuation are given in Table 1.

### Identification of major PAS of Sone Beel

The study identified and listed Sone Beel's major PAS and the different use and nonuse values. The respondents evaluated the various types of use and nonuse values of the Sone Beel in order of priority using ranks 1, 2, 3, and onwards. A list of major PAS provided by Sone Beel is given in Table 2. The study identified the top five direct-use values, one indirect use, and one nonuse-value only.

Table 1 — Steps followed for total economic valuation<sup>24</sup>

Activities	Methods
Choosing the appropriate assessment approach	Literature study
Identified and listed the products and services	Observations, group discussions with stakeholders
Listing of direct use values, indirect use values, and nonuse values	Review of literature
Ranking in terms of importance of use and nonuse values	Scoring of products and services by each category of stakeholders
Selection of the valuation techniques	Review of previous research papers and selection of the optimal techniques
Data collection	Household Survey
Quantify the values & services	Analysis

Sources: adapted from Baral *et al.* (2016)

Table 2 — A list of the PAS of Sone Beel

Values	PAS	List of products and services in order of priority
Direct use values	1. Fish	1. Fish
	2. Paddy cultivation	2. Paddy cultivation
	3. Duck rearing	3. Duck rearing
	4. Water transport	4. Water transport
	5. Tourism/recreation	5. Tourism
	6. Habitat/nursery	
	7. Firewood/fuelwood	
	8. <i>Heezol</i> tree	
	9. Wildlife harvesting	
	10. Food for domestic animal	
	11. Hunting of birds	
	12. Sand extraction	
Indirect use values	13. Livestock Grazing	1. Biodiversity conservation
	14. Groundwater recharge	
	15. Biodiversity conservation	
	16. Livestock bathing	
	17. Water supply	
	18. Carbon sequestration	
	19. Flood control	
Nonuse value	20. Educational purpose	1. Future use
	21. Future Value	

Source: Authors

### Valuation methods

The economic values of the benefits of Sone Beel were quantified using three valuation methods. These are the Market Price Method (MPM), Travel Cost Method (TCM), and Contingent Valuation Method (CVM). The MPM is used to estimate the direct use values<sup>25</sup>. This approach involves calculating the value in the commercial markets for wetland resources. This is a straightforward and efficient method for determining the value of wetland PAS. By directly assessing wetland products' consumption and sale value, we can accurately gauge their value<sup>26</sup>. This approach involves using questionnaires to gather data on the market prices associated with the purchase and sale of wetland products. By examining market prices, we can gain insights into individual's willingness to pay (WTP) for wetland products and the significance they place on them<sup>27</sup>. The MPM can be employed in markets characterised by intense competition and the absence of price distortions for the ecosystem, assuming that it accurately represents the WTP for the PAS<sup>27</sup>.

TCM is an economic technique used to estimate the value of non-market goods not exchanged in the market<sup>28</sup>. TCM is used to calculate the economic use values attached to the places that are used for recreation. In general, it is the expenses, in terms of money, that occur during the time of travel by people to visit a site. Thus, people's WTP for visiting the site can be calculated by considering the number of visits they make. The expenditure on tourism considers the time spent on the place, food and accommodation expenses, recreational activities, and travel costs. Five questionnaires were used to collect data for five direct-use values.

The CVM is used for indirect use values and nonuse values. In CVM, individuals are asked how much they would be willing to pay for specific environmental services for conservation in a hypothetical market. Using a bidding game, the surveyed households were asked how much they would contribute in cash or kind for indirect use and nonuse value. Efforts were made to create situations in the bidding game that would make responders believe they would have to contribute the amount in cash or kind.

### Contingent Valuation Method

The National Oceanic Atmospheric Administration (NOAA) panel has suggested the utilisation of a dichotomous choice (DC) format and face-to-face interview in Contingent Valuation (CV) studies<sup>29</sup>. The DC format has demonstrated its effectiveness in

minimising strategic, design, and interview biases, consequently improving the accuracy and dependability of the gathered data.

### The questionnaire

The questionnaire for the CV study consisted of three distinct sections. The first section comprised questions about the respondent's awareness, attitudes, and knowledge regarding Sone Beel's environment. The second section focused on CV questions. This section created a hypothetical market scenario, proposing a fund, namely, the Sone Beel Development Fund (SBDF), that prioritised biodiversity conservation and future use of Sone Beel. DC questions were used to determine the respondents' WTP, followed by an open-ended question to estimate their maximum WTP. To accomplish this, the initial bid was set at Rs 50 per year, based on the pilot study's findings. The bid ranged from Rs 50 to 1600. The respondents were asked to specify the maximum WTP amount in cash or voluntary labour. The third section of the questionnaire focuses on the respondent's socio-economic characteristics, encompassing age, gender, marital status, household size, family status, educational level, occupation, income, and other relevant variables that could have influenced their WTP response.

### Estimation of WTP

In the DC format of the CVM, the WTP value is expressed as a binary choice dependent variable. A value of 1 signifies a 'Yes' response, while 0 signifies a 'No' response. Furthermore, the bid amount differs among respondents; the only data collected from each respondent is their maximum WTP.

### Data collection and survey design

Initially, the selection of participants for the focus groups and in-depth interviews was conducted. The focus group consisted of knowledgeable persons, political leaders, social workers, and residents. Focus group discussions (FGDs) were conducted in the study area to identify the major stakeholders of the Sone Beel and to gather information about the study site, its important PAS, present status, utilisation, and management pattern of the wetland. The study found major stakeholders of Sone Beel, such as fishermen, paddy cultivators, duck rearers, boatmen, visitors, residents, etc. Following the FGDs, a questionnaire was prepared to conduct a pilot survey. Based on the data collected in the pilot survey, the questionnaire was restructured to incorporate essential modifications.

Table 3 — Distribution of sample households

Sl. No.	Sample villages	Sample size <sup>30</sup>	Fishing	Paddy	Duck rearing	Water transport
1.	Niznabin	149	29	17	27	76
2.	Sailanagar	53	25	15	7	6
3.	Swastipur	30	16	0	4	10
4.	Anandapur	41	11	3	5	22
5.	Debodwar	62	20	0	12	30
6.	Gopikanagar	33	5	16	11	1
7.	Fakua	59	21	10	13	15
8.	Nagendranagar	150	59	78	10	3
Total		577	186	139	89	163

Source: Authors

Using the modified questionnaire, the main survey was conducted from April 2021 to January 2023.

In this study, clustered sampling and simple random sampling techniques were used. The purpose of employing the clustered sampling method was to minimise any potential biases that may arise while selecting households for interviews. Furthermore, simple random sampling ensured that no specific types of respondents were systematically excluded, providing an equal opportunity for every household to be surveyed.

Following FGDs and consulting with stakeholders, we divided the whole area into eight clusters. From each cluster, one village that falls within the range of 5 km was purposively selected for the study. Sample households were selected from each village by applying a simple random sampling method. The sample selection was done based on two factors, viz., (i) land holding and (ii) dependency level to the wetland. The list of the households was collected from the Gaon Panchayat offices for each sample village. There were altogether 1,924 households in these villages. According to the Secretary of Sone Beel Fishermen Co-operative Society Limited (SBFCSLtd.), the total household size of the Sone Beel area is approximately 5770. A total of 577 sample households were selected. Furthermore, 78 visitors were also surveyed to estimate the value of tourism. Thus, the total sample size of the study was 655. The distribution of sample households and the distribution of sample size with respect to the various stakeholders are given in Table 3 and Table 4 respectively.

The study was mainly based on primary data. Secondary data is also considered in this study. After identifying the major stakeholders and the benefits of Sone Beel, a household survey and a modified, well-structured questionnaire were carried out to collect data on direct use values. This questionnaire incorporated the questions to obtain information about the dependency of the communities on wetland resources,

Table 4 — Distribution of sample size with respect to the various stakeholders

Sl. No.	Stakeholder	Sample size
1	Fishermen	186
2	Paddy cultivators	139
3	Duck rearers	89
4	Boatmen	163
5	Visitors	78
	Total sample size	655

Source: Authors

the current status of the wetland, the socio-economic characteristics of the respondents, and their perceptions about the deficiencies of the current conservation and management pattern of the wetland.

In the case of indirect use value and nonuse value, the study used a CV survey to collect data. Secondary data were collected from the Gaon Panchayat Office, Circle Office, SBFCS's office, etc.

#### Analytical methods for calculation of direct use values

Three indicators were used to express the monetary value of the PAS of wetland provisional services. These were the Gross Financial Value (GFV), Net Financial Value (NFV), and Cost Incurred (CI)<sup>31</sup>. The market value is equal to the aggregate net present value of commodities produced in the area<sup>32</sup>. The net present value of paddy cultivation in the area depends on crop type, soil productivity, irrigation, crop prices, and production cost<sup>32</sup>.

#### Valuation of fishing activities

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

$$GFV = AHF \times P \times NH \quad \dots (1)$$

where AHF stands for the altogether average household fish catch per year

P stands for market price of fish per unit

NH stands for the total number of households involved in fishing in Sone Beel

GFV stands for gross financial value, i.e., the total monetary value of fish caught per year

Therefore,

$$NFV = GFV - CI - 5\% \text{ of } GFV - GR \quad \dots (2)$$

where NFV= Net financial value, i.e. net monetary benefit from fishing per year

CI= Cost incurred in fishing per year

GR= Govt. revenue

Again,

$$CI = \text{Sum of total cost incurred in fishing per year} \\ = (N + M + O + B) \quad \dots (3)$$

where N stands for total cost of net and other fishing gear per year

M stands for cost of maintenance of net and other fishing gear per year

O stands for other expenditure, which includes the total cost of containers for fish stock, etc.

B stands for total cost of fishing boat and maintenance per year

#### *Valuation of paddy cultivation*

For valuing the paddy cultivation, net monetary benefits from commercial paddy cultivation were estimated with the help of the following expression

$$GFV = TQP \times P \quad \dots (4)$$

where GFV = Total monetary value of production per household per year

TQP = Total quantity of production per household per year

P = Average market price of the production per unit

$$NFV = GFV - CI - HC \quad \dots (5)$$

where,

CI stands for the sum of total cost incurred for production per year, excluding the cost of family labour.

HC stands for home consumption of production per household per year

NFV stands for the net monetary benefit of production per household

Finally,

$$PC = NFV \times NH \quad \dots (6)$$

where,

PC stands for net monetary benefit for paddy cultivation

NH stands for the number of total households

#### *Valuation of water transport*

For valuing water transportation, net monetary benefits from boating were estimated as follows

$$B = \sum (TIM + TIN) \quad \dots (7)$$

where,

B = Net monetary annual benefits from boating

TIM = Total income from motorized boat per household per year

TIN = Total income from non-motorized boat per household per year

Now,

$$TIM = NHM \times NIM \quad \dots (8)$$

where NHM= Number of households having motorized boats

NIM = Net income from motorized boats

And,

$$CI (M) = CM + MM + EM \quad \dots (9)$$

where,

CM = Cost of motorized boat per annum

MM = Maintenance of motorized boat per annum

EM = expenditure on a motorized boat

Therefore,

$$\text{Net Income (M)} = \text{Gross Income (M)} - CI (M) \quad \dots (10)$$

where, Gross income (M) = Income from motorized boat.

Again,

Similarly,

$$TIN = NHN \times NIN \quad \dots (11)$$

where NHN= Number of households having non-motorized boats

NIN= Net income from non-motorized boat

$$CI (N) = CN + MN + EN \quad \dots (12)$$

where CN= Cost of non-motorized boat

MN = Maintenance of non-motorized boat

EN= expenditure on non-motorized boat

Therefore,

$$\text{Net Income (N)} = \text{Gross income (N)} - CI (N) \quad \dots (13)$$

where Gross Income (N) = Income from non-motorized boat.

#### *Valuation of duck-rearing*

Three indicators, Gross Financial Value (GFV), Net Financial Value (NFV), and Cost Incurred (CI),

were used to estimate the duck rearing. These values were computed as follows

$$GFV = \sum [CEP + CMP] \text{ for both seasons in a year} \quad \dots (14)$$

where,

CEP stands for total cost of egg production per household per season

CMP stands for total cost of meat production per household per season

GFV stands for the total production of eggs and meat per year

Again,

$$CEP = QEP \times SPE \quad \dots (15)$$

where QEP stands for the quantity of egg production per household per season

SPE stands for selling price per egg per season

$$\text{And, } CMP = QRD \times SPD \quad \dots (16)$$

where QRD stands for the quantity of remaining ducks per household per season

SPD stands for selling price per duck per season

TQP= Sum of the Total annual quantity of egg and meat produced per household.

Now,

CI= sum of total cost incurred per household per year

$$= S + D + F + M \quad \dots (17)$$

where S stands for the cost of shed per household

D stands for the average cost of total ducks per household

F stands for the average cost of food for total ducks per household

M stands for the medicine used for ducks per household

Therefore,

$$NFV = GFV - CI \quad \dots (18)$$

where NFV stands for the net monetary benefit for duck rearing per household per year

Finally,

$$D = NFV \times NH \quad \dots (19)$$

where,

D stands for the net benefit for duck rearing in Sone Beel

NH = total number of households involved in duck rearing in Sone Beel.

### *Valuation of tourism services*

The valuation of tourism is estimated as follows

$$\text{Total Expenditure per visitor} = TE + SE + EF + OE \quad \dots (20)$$

where TE stands for average travelling expenses per visitor

SE stands for in-site expenditure per visitor

EF stands for average expenditure on food/drinking

OE stands for average other expenditure

Therefore,

$$\text{Net benefit from tourism} = TE \times ANV \quad \dots (21)$$

where,

TE stands for total expenditure per visitor

ANV stands for the average number of visitors per year

Again,

average no of visitors per year = (sum of average number of visitors on weekdays and Sundays per week) x (total number of weeks in a month) x (number of months in a year)

### **Analytical methods for calculation of indirect use values and nonuse values using WTP<sup>33</sup>**

The WTP method is the most appropriate method for valuing those benefits that do not have a market value<sup>34</sup>.

total WTP = WTP per household x population size

where WTP per household = sum of the WTP amount in cash and kind

Here, kind refers to voluntary labour, i.e. the number of days per year contribution.

## **Results and Discussion**

### **Valuation of fishing activities**

The valuation of fishing activities was quantified by using the MPM. The main activity in the Sone Beel area is fishing, providing a sustainable livelihood for the surrounding fishing communities. There is a cooperative society, SBFCS Ltd., which has 5,334 members. All the members of the society are the shareholders of the Sone Beel. Fishing is the major source of income for them<sup>35</sup>. They used to catch fish throughout the whole year. In the summer, the fishing communities can freely access fishing in the wetland. However, during the winter season, when the wetland shrinks in total size and gets partitioned into some wetland fisheries, there is a restriction on free or open access to fishing. The fishing communities generally practised two types of fishing: individual fishing (IF) and group fishing (GF).

IF is done with the help of traditional fishing gear and cast nets with a single boat. In GF, the types and nature of fishing gear used differ from those used in IF. Generally, GF is done with the help of 2 to 12 members. Earlier in GF, fish-catching is done by a group with a maximum of 35 members. However, due to the shortage of fish caught, the number of participants decreased day by day. The fishing gears used are seine net, drag net, gill net, cast net, etc. GF is generally practised for six months in the summer season. However, during the summer, fishing activities are restricted for two months for fish breeding following an order by Govt. of Assam, and fishing activities are done only for four months.

To calculate the value of wetlands for fish, information about the income derived from fishing, the cost of various types of fishing gear and tools, the amount of fish caught per day, the market price of caught fish, and expenditure incurred, etc. were collected from the respondents. There are five fish trading centres in the entire Sone Beel area. The fishermen sell their daily fish catch in these trading centres through an auction or a formal bidding system. This fish auctioning and bidding helps the fishermen to get better prices for their daily catch. Catchers are charged 5 per cent of the value of their daily catch as a fee for participation in the organised bidding under the wholesale trading center<sup>19</sup>.

During the winter season, the entire wetland shrinks and is partitioned into some small wetland fisheries and private fisheries. In this season, SBFCS Ltd. leased the wetland for fisheries operation during the period of October-November to March-April every year. In general, the participants in this auction were mostly fishing people, individually or collectively. For the use of the wetland, SBFCS Ltd. pays the Govt. of Assam a total of Rs 18.56 Lakh as revenue from 2021 for the next 7 years. Accordingly, the owner of the small wetland fisheries obtains the monetary benefit by doing fishing activity in the wetland fisheries. So, the number of fishing households decreases in this season due to the absence of free access to the wetland.

Though it is reported that there are 5,334 fishermen in SBFCS Ltd., there is no official record of the total number of fishing households. According to the office bearers of SBFCS Ltd. and other wetland stakeholders, it is estimated that approximately 3,000 households are engaged in fishing daily. The study has collected data from 186 fishing households. Of these 3,000

households, it is seen that all are generally engaged in fishing in the summer season. However, in the winter season, we have estimated that approximately 1,645 households are engaged in fishing. It is because our study showed that out of 186 households, only 102 households engaged in fishing during that season. *Mohajaal* operations (MO) are practised in Sone Beel only for six months of the summer season. The fisherman involved in this type of fishing is on an average of 8 members. Generally, this type of fishing is done with a large fishing net, locally called '*Mohajaal*', which is generally a 1 km long fishing net. *Mahajaal* measured 20 *korai* (or 2,000 hands in measurement), 888.9 meters in length. One bundle of the net (i.e. 30 meters) costs Rs 10,000–12,000. Each *korai* costs Rs 15,000 or 18,000. So, a *Mahajaal* costs a minimum of Rs 300,000 and a maximum of Rs 360,000. Therefore, the average cost of *Mahajaal* is Rs 330,000. Usually, in a single operation, the time is more or less 6 hours a day. MOs are practised at night. In this type of operation, the number of fish caught is uncertain. It may happen that sometimes, in a single operation, a fish catch has either a maximum of 90 kg or a minimum of 10 kg. It is observed that an average of 40 kg of small and big fish are usually caught in MO. It is seen that the catch is found at an average of 3 kg of fish while fishing with a current net, gill net, and other traditional fishing gear. According to the information collected from the fish trading centres of the Sone Beel area, the average rate per kg of fish is not fixed. It fluctuates daily depending upon the market's demand and supply and usually ranges from Rs 150–250. So, we have considered the sale price of fish to be an average of Rs 200 per kg. The GFV of the fish of Sone Beel is Rs 550,278,000 per year, and the NFV of fishing is Rs 474,261,153 per year.

The fishing value is estimated at Rs 474,261,153 per annum, which is almost 4.1 times greater than the value estimated in Deepor Beel, the only Ramsar Site of Assam, and almost 2.4 times greater than the value at Kolleru Lake of Andhra Pradesh, India<sup>7</sup>. The estimated value from Deepor Beel was Rs 116,469,375 per annum<sup>13</sup>, and Rs 200,170,000 per annum from the Kolleru Lake, India<sup>10</sup>. The information about revenue collected from fishing during the summer and winter is given in Table 5 and Table 6 respectively. Again, the information about the cost of nets and other fishing gear needed in a year, information about annual expenditure on maintenance of nets and fishing gears, information about other expenditures

Table 5 —Revenue collected from fishing during the summer

Cost	Amount
Revenue collected from fishing during the summer season	
(A) Average rate of fish per kg (in Rs)	Rs 200
(B) Average household fish catch (IF)	3 kg per day
Average monthly household fish catch (IF)	90 kg per 30 days
Average household fish catch per season (IF)	360 kg per 120 days
Average household income per season (IF)	Rs 72,000 per 120 days
[Fishing activities are restricted for two months]	
(A) Average households fish catch (GF)	40 kg per day
	8
Average number of households involved in group fish catch (GF)	5 kg per day
Therefore, average household fish catch (GF)	150 kg per 30 days
Average monthly household fish catch (GF)	600 kg per 120 days
Average household fish catch per season (GF)	Rs 120,000 per 120 days
Average household income (GF)	4 kg per day
	120 kg per 30 days
(A) Altogether average household fish catch (in kg)	480 kg per 120 days
Altogether average household monthly fish catch (in kg)	Rs 96,000 per 120 days
Altogether average household fish catch per season (in kg)	3000
Altogether average household income (in Rs)	Rs 288,000,000 per summer
(A) Total number of households involved in fishing	
(B) GFV per summer season (in Rs)	

Source: Survey data

Table 6 —Revenue collection from fishing during winter

Cost	Amount
Revenue collected from fishing during the winter season	
(A) Average rate per kg (in Rs)	Rs 200
(B) Average household fish catch (in kg)	3 kg per day
Average monthly household fish catch (in kg)	90 kg per 30 days
Average household fish catch per season (in kg)	540 kg per 180 days
Average household income per season (in Rs)	Rs 108,000 per 180 days
(C) Average fish catch per group (in kg)	30 kg per day
Average number of households involved	5
Therefore, average fish catch per household (in kg)	6 kg per day
Average monthly fish catch per household (in kg)	180 kg per 30 days
Average seasonal fish catch per household (in kg)	1,080 kg per 180 days
Average household income (in Rs)	Rs 216,000 per 180 days
(D) Altogether average fish catch per household (in kg)	$(3 \text{ kg} + 6 \text{ kg})/2 = 4.5 \text{ kg per day}$
Altogether average household monthly fish catch (in kg)	135 kg per household per 30 days
Altogether average household fish catch per season (in kg)	810 kg per household per 180 days
Altogether average household income (in Rs)	Rs 162,000 per 180 days
(E) Total number of households involved in fishing	1,619
(F) Therefore, GFV per winter season (in Rs)	Rs 262,278,000 per winter

Source: Survey data

including the cost of various fish containers etc., information about the annual cost of fishing boats & maintenance cost and the estimation of economic value of fishing is given in Table 7, Table 8, Table 9, Table 10 and Table 11 respectively.

#### Valuation of paddy cultivation

The value of paddy cultivation was estimated by using the MPM. Paddy cultivation is also practised

throughout the whole year. The whole year is divided into two seasons. In summer, a huge water volume covers the whole Sone Beel area. This leads to the majority of the cultivable land of the people going under the water of the wetland for six months or more. Only the upland residents can cultivate paddy in this season. In winter, out of a total of 3,458 hectares of the land of Sone Beel, around 2,700 hectares of land are used for paddy cultivation. This is

Table 7 — Cost of nets and other fishing gears needed in a year

Cost	Amount
<b>(A) Cost of nets and other fishing gears needed in a year</b>	
I.	
<i>For small fish catch,</i>	
Average cost of net (Thin) in Rs	Rs 8,000
Average economic life of net (Thin) in years	7 years
Average cost of net (Thin) per year	Rs 1,143 per year
Average households involved in fish caught by net (Thin)	80 households
Average cost of net (Thin) for 80 households	Rs 91,440 per year
<b>Average cost of net (Thin) for 1,290 households (out of 3000 households)</b>	Rs 1,474,470 per year
II.	
<i>For small fish catch,</i>	
Average cost of net (Big) in Rs	Rs 7,500
Average economic life of net (Big) in years	7 years
Average cost of net (Big) per year	Rs 1,071 per year
Average households involved in fish catch by net (Big)	60 households
Average cost of the net (Big) for 60 households	Rs 64,260 per year
<b>Average cost of the net (Big) of 968 households (out of 3000 households)</b>	Rs 1,036,728 per year
III.	
<i>For small &amp; big fish catch (in GF),</i>	Rs 330,000
Average cost of the net ( <i>Mahajaal</i> )	8 nos
In group fishing, average number of households involved (in numbers)	Rs 41,250
Therefore, average cost of nets ( <i>Mahajaal</i> ) per household	7 years
Again, average economic life of nets ( <i>Mahajaal</i> ) in years	Rs 5,893 per year
Therefore, average cost of nets ( <i>Mahajaal</i> ) per household	
Now,	15 households
Number of households involved in <i>Mahajaal</i> operation	Rs 88,395 per year
Average cost of nets ( <i>Mahajaal</i> ) for 15 households	Rs 1,426,106 per year
<b>Average cost of nets (<i>Mahajaal</i>) for 242 households (Out of 3000 households)</b>	
IV.	
Average cost of traditional fishing gears, tools, etc.	Rs 4,000 per year
Number of households involved in traditional fishing	31 nos
Therefore, Total cost of traditional fishing gears, tools, etc. for 31 households	Rs 124,000 per year
<b>Total cost of traditional fishing gears, tools, etc. for 500 households</b>	Rs 2,000,000 per year
Therefore, <b>(A1) Total cost of the net and other fishing gear needed in a year for 3000 households i.e. (I+II+III+IV)</b>	Rs 5,937,304 per year

Source: Survey data

Table 8 — Annual expenditure on maintenance of nets and fishing gears

Cost	Amount
<b>(B) Expenditure on maintenance of nets and fishing gears</b>	
I. Maintenance cost of nets (thin & big) per household	Rs 5,000 per year
Therefore, Maintenance cost of nets of 140 households	Rs 700,000 per year.
<b>Maintenance cost of nets of 2,258 households (Out of 3,000 households)</b>	Rs 11,290,000 per year
I. Maintenance cost of traditional gears, tools, etc. per household	Rs 2,000 per year
Therefore, Maintenance cost of traditional gears, tools, etc. for 31 households	Rs 62,000 per year
<b>Maintenance cost of traditional gears, tools, etc., for 500 households (Out of 3,000 households)</b>	Rs 1,000,000 per year
I. Maintenance cost of <i>Mahajaal</i> (net)	Rs 30,000 per year
Average number of households involved	8 nos
Therefore, the average maintenance cost of <i>Mahajaal</i> (net)	Rs 3,750 per household per year
Therefore, maintenance costs for 15 households	Rs 56,250 per year
<b>Therefore, maintenance cost for 242 households (Out of 3,000 households)</b>	Rs 907,500 per year
<b>(B1) Total maintenance cost for 3,000 households (I+II+III)</b>	Rs 13,197,500 per year

Source: Survey data

Table 9 — Other expenditures, including the cost of various fish containers, etc.

Cost	Amount (in Rs)
<b>(C) Other expenditure (cost of various fish containers etc.)</b>	
I. Average cost of fish containers etc. for thin & big net operation (for winter season). Therefore, total average cost of fish containers etc. for 66 households.	2,000 per year. 132,000 per year
II. Average cost of fish containers etc. for thin & big net operation (for whole year) Therefore, total average cost of fish containers etc. for 74 households	1,300 per year 96,200 per year
III. Average cost of fish containers etc. for MO (for whole year) Therefore, total average cost of fish containers etc. for 15 households	2,500 per year 37,500 per year
IV. Average cost of fish containers etc. for traditional fishing (winter season) Therefore, total average cost of fish containers etc. for 15 households	1,100 per year 16,500 per year
V. Average cost of fish containers etc. for traditional fishing (whole year) Therefore, total average cost of fish containers etc. for 16 households	1,800 per year 28,800 per year
Now,	
VI. Total average cost of other expenditure for 186 households i.e. (I+II+III+IV+V) Total average cost of other expenditures per household	311,000 per year 1,672 per year
Therefore, (C1) Total average cost of other expenditures for 3,000 households	5,016,000 per year

Source: Survey data

Table 10 — Annual cost of fishing boats and maintenance cost

Cost	Amount
<b>(D) Cost of fishing boat &amp; maintenance cost</b>	
I. Average cost of big boat (in Rs) Average economic life of big boat (in years) Therefore, average cost of big boat per year	Rs 30,000 7 years Rs 4,286 per year
II. Average cost of small boat III. Average economic life of small boat Therefore, average cost of small boat per year	Rs 15,000 7 years Rs 2,143 per year
<b>VI. Altogether, average cost of both types of boat</b>	Rs 6,429 per year
V. Cost of maintenance of big boat per year Cost of maintenance of small boat per year	Rs 1,200 Rs 400
<b>Cost of maintenance of both types of boat per year</b>	Rs 1,600
VI. Therefore, total cost of the boat and maintenance (III+IV) Now,	Rs 8,029 per household per year
<b>(D1) Total cost of boat and maintenance for 3000 households</b>	Rs 24,087,000 per household per year

Source: Survey data

Table 11 — Estimation of the economic value of fishing

Cost	Amount (in Rs)
GFV	550,278,000 per year
5% of GFV	27,513,900 per year
CI	48,237,804 per year
Govt. Revenue	265,143 per year (Rs 1,856,000 for 7 years)
NFV	474,261,153 per year
<b>Economic value of fishing (Net monetary benefit from fishing)</b>	474,261,153 per year

Source: Survey data

followed by wetland fisheries of 485 hectares, fisheries of 174 hectares, and wasteland of 99 hectares<sup>18</sup>. To estimate the value of wetlands for paddy cultivation, information about the yields, cost, expenditure incurred, the numbers of production per season, market price, etc., were collected from the respondents.

The study also showed that traditional paddy cultivation has an important economic contribution to the livelihood of the surrounding people of the Sone Beel area. Among the respondents, some have their land deed on the wetland area, and some do not. They used to cultivate paddy on the wetland land area. Besides paddy cultivation, the surrounding people

used to cultivate some vegetables like potatoes, brinjal, chilli, cauliflower, cabbage, etc., which are negligible in amount. They used to cultivate these vegetables only for home consumption. In this season, only the upland residents can cultivate paddy. While surveying 139 numbers of sample households, out of 910 bighas (121.74 hectares) of land, only 310 bighas (41.47 hectares) of land can be cultivated in the summer season. In winter, out of a total of 3,458 hectares of the land of Sone Beel, around 2,700 hectares of land is cultivable. However, after discussing with the stakeholders of Sone Beel, it is found that around 1,500 to 1,600 hectares of land are used for cultivation nowadays. It is also seen that a total of approximately 950 households are engaged in paddy cultivation. In this season, 'Buroh' rice is produced at an average of 480 kg/bigha. According to the respondents, nowadays, paddy cultivation is not considered a profitable activity. Sometimes, early heavy rain damages the yields. In such a situation, the gain may be considered total zero or loss. The economic value of wetlands for paddy cultivation is estimated at Rs. 6,977,351 per year.

The value of paddy production is Rs 6,977,351 per annum, which is also 3.45 times greater than the value estimated for Deepor Beel at Rs 2,023,000 per annum<sup>13</sup> but less than the value estimated for Kolleru Lake of Rs 727,220,000 per annum<sup>10</sup>. The information on the cost incurred, revenue collection, and home consumption from paddy cultivation in the winter and summer seasons is given in Table 12 and Table 13 respectively. Table 14 shows the estimation of the economic value of paddy cultivation.

#### Valuation of duck-rearing

The value of duck rearing was estimated by using the MPM. Rearing of ducks is another important occupation of the surrounding fishing communities of Sone Beel. It is found in practice mainly in the wetland bed and the peripheral villages of the Sone Beel. The study selected 89 families engaged in duck rearing as a sample size for the survey. The study observed that there is no official record of the total number of duck rearers and the total number of ducks in the entire Sone Beel area. From the survey of 89 sample households, a total of approximately 14,240

Table 12 — Cost incurred, revenue collection, and home consumption from paddy cultivation in the winter season

Cost	Amount
<b>(A) Cost Incurred</b>	
Cost for planter per bigha	Rs 500
Cost of ploughing per bigha	Rs 480
Cost of irrigation per bigha	Rs 0
Cost of pesticides per bigha	Rs 150 (3 kg @ Rs 50)
Cost of seeds per bigha	Rs 150 (5kg @ Rs 30)
Cost born during harvesting per bigha	Rs 1,500
Power triller separating paddy	Rs 400
Labour	Rs 250 including family labour
<b>Total cost per bigha</b>	Rs 3,430
Total cost for 910 bighas (for 139 households)	Rs 3,121,300
Total cost for 6.55 bigha per household	Rs 22,455.39
<b>(B) Revenue Collection</b>	
Production of paddy per bigha	12 Mon
Production of paddy per bigha (in kg)	480 kg
Total production for 910 bighas (for 139 households)	436,800 kg
Average market price per Mon (i.e. 40 kg)	Rs 500
<b>Average market price of paddy per kg (in Rs)</b>	Rs 12.5
Total production of paddy per bigha (in Rs)	Rs 6,000
Total production for 910 bigha (139 households)	Rs 5,460,000
<b>Total quantity of production per household (in kg)</b>	<b>3,142.44 kg</b>
Total production per household (in Rs)	Rs 39,280.57
<b>(C) Home Consumption (HC)</b>	
Consumption per household (monthly)	3 Mon
Consumption per household per 30 days (in kg)	120 kg
Consumption per household per season (in kg)	720 kg
Consumption per household per season (in Rs)	Rs 9,000

Source: Survey data

Table 13 — Cost incurred, revenue collection, and home consumption from paddy cultivation in the summer season

Cost	Amount
<b>(A) Cost Incurred during the summer season</b>	
Cost for planter per bigha	Rs 500
Cost for plugging per bigha	Rs 480
Cost of irrigation per bigha	Rs 0
Cost of pesticides	Rs 150 (3 kg @ Rs 50)
Cost of seeds per bigha	Rs 150 (5kg @ Rs 30)
Cost born during harvesting per bigha	Rs 1,000 including family labour
Power triller separating paddy	Rs 400
Labour	Rs 0 (family labour)
<b>Total cost per bigha</b>	Rs 2,680
Total cost for 310 bigha (for 139 households)	Rs 830,800
<b>Total cost per household per season (in Rs)</b>	<b>Rs 5,976.98</b>
<b>(B) Paddy Production</b>	
Production per bigha	13 Mon
Production per bigha (in kg)	520 kg
Production for 310 bigha (139 households)	161,200 kg
Production per bigha (in Rs)	Rs 6,500
Production for 310 bigha (for 139 households)	Rs 2,015,000
<b>Total quantity of paddy per household (in kg)</b>	1,159.71 kg
Total production per household (in Rs)	Rs 14,496.38
<b>(C) Home Consumption</b>	
Consumption per household (monthly)	3 Mon
Consumption per household per 30 days (in kg)	120 kg
Consumption per household per season (in kg)	720 kg
Consumption per household per season (in Rs)	Rs 9,000

Source: Survey data

Table 14 — Estimation of economic value of paddy cultivation

Cost	Amount
GFV	Total production of paddy per household in both seasons =Rs 53,776.95
CI	Annual CI=Rs 28,432.37
NFV	GFV- CI – HC= Rs 7,344.58 per household
Economic value of paddy (for 950 households)	Rs 6,977,351 per annum

Source: Survey data

numbers of ducks was found. It is estimated that there are 160 and 64 ducks reared per household in the winter and summer seasons, respectively. In the northern part of the wetland, some duck rearers are employed in duck rearing throughout the year. However, in the southern part, some households practised this only for six months, from November to April yearly. Artificial foods were not used for rearing ducks, and they were fed with about 70 g of rice/day for Rs. 0.88/day. The stakeholder bought the ducks for Rs 200 per duck. The ducks are adults and can produce eggs for one or one and a half months later. The ducks are released to the wetland in the morning and are driven back to the housing sheds in the evening. The housing sheds are covered by fishing nets. The study estimated approximately Rs 113,600 per household as the gross production from duck rearing in winter and Rs 43,520 per household in

summer. In the summer season, the sale rate of the egg varies from Rs 700 to Rs900 per set of 100 eggs. So, the average price is considered Rs 8 per egg in the summer, and in the winter, it costs Rs 8.5 per egg. The net benefit in the winter season is estimated at Rs 14,256 per household per season; in summer, it is estimated at Rs 15,882.4 per household per season. Altogether, the net benefit of duck rearing is estimated at Rs 30,138.4 per household per year. Currently, the total number of households involved in duck rearing in the Sone Beel area is not available. However, approximately 1,000 families were engaged in this activity. This is according to the office bearers of SBFCS Ltd. and other stakeholders. The net benefit from duck rearing is estimated at Rs 30,138,400 per annum.

Duck rearing is another profitable activity practised in Sone Beel, and the value is estimated as

Rs 30,138,400 per annum, which is less than the value of Kollure Lake, where the value was estimated at Rs 429,480,000 per annum<sup>10</sup> but greater than that of the Vellayani Lake of Kerala which was estimated at Rs 379,000 per annum<sup>12</sup>. The information on cost incurred and revenue collection in the summer and winter seasons are given in Table 15 and Table 16 respectively. Table 17 shows the estimation of the economic value of duck rearing.

#### Valuation of water transportation

The value of water transportation was estimated by using MPM. Sone Beel is about 17 km away from the Karimganj town of Assam. The nearest way to connect with the district headquarters from Sone Beel is via Fakua railway station. From Fakua village, rail and bus services are available to communicate with Karimganj town. There are four locations in the Sone Beel where water transportation takes place: Fakua, Kalibari, Kalyanpur, and Debodwar. In the winter season, Fakua to Kalibari water transport is not practised due to the dry-up of water in the wetland. In

this season, surrounding people can travel between these two places by foot.

Water transportation is another important activity in Sone Beel. The peak season is the summer season. In summer, generally, the household used motorised boats for transport to either side of the wetland. The traditional non-motorized boat also plies in the wetland for the same purpose. On average, a motorised boat can carry 40 people per trip, and sometimes traditional non-motorized boats can carry 14-15 people per trip. Discussing with the stakeholders, it was observed that a total of 45 motorised boats are plying in Sone Beel. Though there are more than 2,000 boats that are plying in Sone Beel for fishing and other purposes, it is seen that the traditional non-motorized boats that used to carry passengers from one place to another are estimated at around 300 boats. In the winter season, because of the decrease in water volume of Sone Beel, the income of the boat service is estimated as low as compared to the summer season. The economic value of the motorized boat is estimated at

Table 15 — Cost incurred and revenue collection in the summer season

Cost	Amount
<b>Cost Incurred during the summer season</b>	
<b>I. Average cost of shed</b>	Rs 1,500 per household
II. Average cost of duck	Rs 200
<b>III. Average cost of 64 ducks</b>	Rs 12,800 per household
IV. Food for duck per day (in grams)	70 g of rice per day
Cost of 40 kg rice (in Rs)	Rs 500
Food for duck per day (in Rs)	Rs 0.88
Average cost of food for ducks for 180 days	Rs 158.4 per 180 days
<b>Average cost of food for 64 ducks (180 days)</b>	Rs 10,137.6 per household
V. Medicine per duck	Rs 50
<b>Medicine per 64 ducks</b>	Rs 3,200 per household
<b>Revenue collection during the summer season</b>	
<b>Egg Production</b>	
Egg production (in no.)	0.5 per day
Total number of ducks in 89 sample households	5,696
<i>(Assuming out of 500 ducks 300 number of ducks lost their life due to Strom, flue, hunting, etc.)</i>	
Total number of ducks per household	
Therefore, 64 ducks produce eggs per day	64
Therefore, 64 ducks produce eggs per month	32 no.
64 ducks produce eggs per season (120 days)	960 eggs per 30 days
<b>Selling price of an egg</b>	3,840 eggs per 120 days
<b>Total cost of egg production (in Rs)</b>	Rs 8
<b>Meat Production</b>	Rs 30,720 per summer
From a unit of 500 ducks	
From a unit of 64 ducks	
Average selling price of a duck	200 number of ducks remain (300 ducks lost)
<b>Total cost of meat production (in Rs)</b>	25.6 number of ducks remains
	Rs 500
	Rs 12,800 per summer

Source: Survey data

Table 16 — Cost incurred and revenue collection in the winter season

Cost	Amount
<b>During winter season</b>	
<b>Cost Incurred</b>	
<b>I. Average cost of shed</b>	Rs 10,000 per household
II. Total number of ducks in the 89 households (in no.)	14,240
Total number of ducks per household (in no.)	160 no.
Cost of a duck	Rs 200
<b>Total cost of 160 ducks per household</b>	Rs 32,000
III. Food per duck	70 grams rice per day
Cost of 40 kg of rice	Rs 500
Food for a duck (in Rs)	Rs 0.88 per day
Cost of food for duck per month	Rs 26.4 per 30 days
Average cost of food for ducks per 180 days	Rs 158.4 per 180 days
<b>Average cost of food for 160 ducks (180 days) per household</b>	Rs 25,344 per 180 days
IV. Medicine per duck	Rs 200
Medicine for 160 ducks	Rs 32,000 per household
<b>V. Total cost incurred per season (I+II+III+IV)</b>	Rs 99,344 per household
<b>Revenue collection</b>	
<b>Egg production</b>	
Egg production per duck (in no)	0.5 per day
Egg production per duck per month (in no)	15 eggs per 30 days
Egg production per duck per 120 days (in no)	60 eggs per 120 days
Egg production by 160 ducks per household (in no)	9,600 eggs 120 days
Selling price of an egg	Rs 8.5
<b>Total cost of egg production (in Rs)</b>	Rs 81,600 per household
<b>Meat Production</b>	
From a unit of 500 ducks	200 ducks remain(300 ducks lost)
From a unit of 160 ducks	64 ducks remain
Selling price of duck	Rs 500
<b>Total cost of meat production (in Rs)</b>	Rs 32,000 per household

Source: Survey data

Table 17 — Estimation of the economic value of duck-rearing

Values	Summer (in Rs)	Winter (in Rs)	Altogether (in Rs)
GFV	43,520	113,600	Rs 157,120
CI	27,637.6	99,344	Rs 126,981.6
NFV	15,882.4	14,256	Rs 30,138.4
Total number of households	1,000	1,000	1,000
Net benefit	15,882,400	14,256,000	Rs 30,138,400

Source: Survey data

approximately Rs 2,665,800 per year, and the value of the traditional non-motorized boat is estimated at Rs 25,730,100 per year. Altogether, the value of water transportation is estimated at Rs. 28,395,900 per year. The information about the cost of boats and expenditure per trip in both seasons, income from boating in both seasons, and estimation of the economic value of water transportation is given in Table 18, Table 19, and Table 20 respectively.

#### Valuation of tourism services

The value of tourism services was estimated by using the TCM. Visitors are those who visit the wetland for recreation, spiritual or cultural activities. Based on the pilot survey, the main recreational areas

identified were Debodwar and Kalibari. The data collection was done during both seasons. Visitors used to come in the summer season for multiple purposes as travelling the wetland area by waterway, for sports boating, watching the scenic beauty of the small sea-like wetland Sone Beel, and for recreational purposes. In the winter season, visitors come to watch the Siberian migratory bird for photographic and picnic purposes.

The value of tourism services is calculated using the total earnings from the tourists. There is no recorded data on the number of tourists per day or year. The study collected data on the total earnings from tourists visiting the Sone Beel wetland. The

study surveyed 78 visitors at different times to calculate the total expenditure incurred by tourists. The outlay was calculated by considering the time spent on the site, expenses on food and accommodation, expenses on recreational (boating) activities, and travel costs.

There are lots of visitors who used to visit Sone Beel for recreation and other purposes. Discussing with the boatman, hotel owner, other stakeholders of the locality, and field observation, it is estimated that 80 to 100 visitors usually visit Sone Beel daily. The number of visitors is estimated at approximately 200 to 400 on Sundays or other holidays. People visit the area throughout the year, but the number of visitors is maximum during summer. As there are limited tourism facilities in the Barak Valley of Assam, most visitors come to see the beauty of sea-like water for recreational purposes. The scenic beauty of Sone Beel is very natural. This study showed that 60.26 and 24.36 per cent of visitors used to visit Sone Beel once and twice, respectively, within the last twelve months.

The percentage of visitors coming to Sone Beel for recreational purposes is estimated to be 43.59 per cent, followed by 30.77 per cent for religious purposes, 12.38 per cent for sightseeing or scenic beauty, and 10.26 per cent for picnic purposes. The study revealed that 78 household respondents (considering a 'group of peoples/friends' as a single household) consist of 298 visitors. Therefore, 40,320 visitors belong to 10,554 households. In the Sone Beel area, no accommodation facility is available for tourists. The average expenditure is estimated based on the cost of travel, insight expenses, and the cost of food. Visitors from inside Karimganj, visitors from outside Karimganj but within Barak Valley, visitors from outside Barak Valley but within Assam, and visitors outside Assam are estimated to be 61.54 per cent, 30.77 per cent, 1.28 and 6.41 respectively, during a visit. Total expenses incurred by a visitor are estimated at Rs 317. The total value of the tourism services is estimated at Rs 12,781,440 per year.

Table 18 — Cost of boats and expenditure per trip in both seasons

Cost	Amount
<b>Cost of boat</b>	
I. Average cost of motorized boat (in Rs)	Rs 150,000
Economic life of motorized boat (in years)	10 years
Average cost of motorized boat per year	Rs 15,000
Maintenance per year (in Rs)	Rs 10,000
<b>Total cost of motorized boat per year (in Rs)</b>	Rs 25,000
II. Average cost of non-motorized boat (in Rs)	Rs 35,000
Economic life of non-motorized boat (in years)	6 years
Average cost of non-motorized boat per year	Rs 5,833
Maintenance per year (in Rs)	Rs 2,000
<b>Total cost of non-motorized boat per year (in Rs)</b>	Rs 7,833
<b>Expenditure per trip for motorized boat during summer</b>	
I. Number of Trip on weekdays (in no)	6
Number of Trip on Sunday (in no)	3
Total number of Trip per week (in no)	9
Total number of Trip per month (in no)	36
<b>Total number of Trip per season (in no)</b>	216 (for 180 days)
II. Kerosine needed for 10 km per trip (in L)	4 L
Cost of Kerosine per L	Rs 60
<b>Kerosine needed for 10 km waterway (in Rs)</b>	Rs 240 per trip
III. Kerosine needed for 10 km waterway for 216 Trip i.e.	
<b>Total expenditure per trip for motorized boat</b>	Rs 51,840
<b>Expenditure per trip for motorized boat during winter</b>	
IV. Number of Trip on weekdays per household	6
Number of Trip on Sunday per household	3
Total number of Trip per week per household	9
Total number of Trip per month per household	36
<b>Total number of Trip per season</b>	108 (for 90 days)
V. Kerosine needed for 10 km per Trip (in L)	4 L
Cost of Kerosine per L (in Rs)	Rs 60
<b>Kerosine needed for 10 km waterway (in Rs)</b>	Rs 240 per trip
VI. Kerosine needed for 10 km waterway for 108 Trip, i.e. <b>Total Expenditure per trip for non-motorized boat</b>	Rs 25,920

Source: Survey data

Table 19 — Income from boating in both seasons

Cost	Amount
<b>Income (During the summer season)</b>	
<i>I. For motorized boat</i>	
Average income rate per trip	Rs 600
Average income per household during weekdays	6 times x Rs 600 = Rs 3,600
Average income per household on Sunday	3 times x Rs 600 = Rs 1,800
Therefore, average income per household per week	Rs 5,400
Average income per household per month	Rs 21,600 per 30 days
<b>Total income per household per season</b>	Rs 129,600 per 180 days
<i>II. For non-motorized boat</i>	
Average income rate per trip	Rs 300
Average income per household on weekdays	6 times x Rs 300 = Rs 1,800
Average income per household on Sunday	3 times x Rs 300 = Rs 900
Average income per household per week	Rs 2,700
Average income per household per month	Rs 10,800 per 30 days
<b>Total income per household per season</b>	Rs 64,800 per 180 days
<b>Income (During the winter season)</b>	
<i>I. For motorized boat</i>	
Average income rate per trip	Rs 300
Average income per household on weekdays	6 times x Rs 300 = Rs 1,800
Average income per household on Sunday	3 times x Rs 300 = Rs 900
Average income per household per week	Rs 2,700
Average income per household per month	Rs 10,800
<b>Total income per household per season</b>	Rs 32,400 (for 90 days)
<i>(Assuming the season lasts for 3 months only)</i>	
<i>II. For non-motorized boat</i>	
Average income rate per trip	Rs 300
Average income per household on weekdays	6 times x Rs 300 = Rs 1,800
Average income per household on Sunday	2 times x Rs 300 = Rs 600
Average income per household per week	Rs 2,400
Average income per household per month	Rs 9,600 per 30 days
<b>Total income per household per season</b>	Rs 28,800 (for 90 days)
<i>(Assuming the season lasts for 3 months only)</i>	

Source: Survey data

Table 20 — Estimation of the economic value of water transportation

Value	Amount
(A) Gross income (Motorized boat)	Rs 129,600 + Rs 32,400 = Rs 162,000
Cost incurred (Motorized boat)	Rs 51,840 + Rs 25,920 + Rs 25,000 = Rs 102,760
Net income (Motorized boat)	Rs 162,000 – Rs 102,760 = Rs 59,240
<b>Net benefits (motorized boat)</b>	10 nos. x Rs 59,240 = Rs 592,400 per year
(B) Gross income (non-motorized boat)	Rs 64,800 + Rs 28,800 = Rs 93,600
Cost incurred (non-motorized boat)	Rs 7,833
Net income (non-motorized boat)	Rs 93,600 – Rs 7,833 = Rs 85,767
<b>Net benefits (non-motorized boat)</b>	153 nos. x Rs 85,767 = Rs 13,122,351 per year
<i>(C) According to the information collected, there are 45 motorized boats and 300 non-motorized boats plying in Beel.</i>	
Net benefits for motorized boats for 45 households	45 x Rs 59,240 = Rs 2,665,800
Net benefits for non-motorized boats for 300 households	300 x Rs 85,767 = Rs 25,730,100
<b>Altogether, the net benefit of boating</b>	Rs 28,395,900

Source: Survey data

The value of tourism is estimated at Rs 12,781,440 per annum, which is 1.4 times greater than that of the Jagadishpur Ramsar Site of Nepal, which had an estimated value of Rs 9,076,950 per annum<sup>24</sup>. The distribution of the percentage of visitors against visits

with family, friends, and individuals, the distribution of the percentage of the number of visits for the purpose of visiting, the distribution of the percentage of the number of visitors against visitor's place, the distribution of the percentage of respondents against

Table 21 — Distribution of percentage of visitors against visits with family, friends, and individual

Visit	Number of visitors from the sample	% of visitors	Visitors per year from the population
With Family	34	43.59	17575.49
With Friends	30	38.46	15507.07
Individual	14	17.95	7237.44
Total	78	100	40,320

Source: Survey data

Table 22 — Distribution of the percentage of the number of visits for the purpose of visiting

Purpose of visiting	Number of visits	%
Recreation	34	43.59
Religious	24	30.77
Site-seeing, scenic beauty	12	15.38
Picnic	8	10.26
Total	78	100

Source: Survey data

Table 23 — Distribution of percentage of the number of visitors against visitor's place

Visitor belongs to the place	Number of visitors	%
Inside karimganj	48	61.54
Outside Karimganj but inside Barak Valley	24	30.77
Outside Barak Vally but inside Assam	1	1.28
Outside Assam	5	6.41
Total	78	100

Source: Survey data

Table 24 — Distribution of the percentage of respondents against their number of visits per year

How many times they visit within 12 months	Number of visitors	%
1	47	60.26
2	19	24.36
4	10	12.82
12	2	2.56

Source: Survey data

their number of visits per year, information about cost and traveling expenses are given in Table 21, Table 22, Table 23, Table 24, and Table 25 respectively.

#### Valuation of biodiversity conservation

Biodiversity plays a crucial role in supporting essential ecosystem services in human beings, such as providing food and raw materials, which are vital for sustaining lives and livelihoods<sup>36</sup>. A central focus of extensive research in biodiversity and ecosystem services is the imperative to conserve biodiversity to enhance human well-being<sup>37,38</sup>.

The study also employs the CVM to estimate the value of biodiversity conservation of Sone Beel. CVM consults directly with human beings to ascertain the amount of money they are willing to pay for biodiversity conservation. Table 26 shows the number of households willing to pay for the conservation of the biodiversity of the Sone Beel. Of the total households surveyed, 399 are willing to pay for the conservation of biodiversity of the Sone Beel. Among them, 392 households are willing to pay in cash, and 336 are WTP in kind for the conservation of biodiversity of the Sone Beel.

Table 27 shows the average household WTP in cash and kind. On average, each household is willing to pay Rs 80.2 per year in cash and also offers 2.1 days of voluntary labour annually (worth Rs 815.2) as part of their overall contribution towards biodiversity preservation within the area. Compared to households' willingness to contribute financially via WTP, those living near Sone Beel are more likely to offer their services through volunteer work, resulting in a higher value placed on conserving this ecosystem's diversity by citizens' hereabouts. This amount would be worth an estimated Rs 4,703,704 if extrapolated across all households in the wetlands area.

#### Valuation of future use

The study employed CVM to quantify the nonuse/future use value of Sone Beel's resources. Table 28 shows the number of households with WTPs for the conservation and management of the Sone Beel for future use. Nearly two-thirds of the households surveyed are willing to pay for future use of the Sone Beel. Of the total households surveyed, 374 are willing to pay for future use of the Sone Beel. Among them, 363 households are willing to pay in cash, and 292 are willing to pay in kind for the conservation of the Sone Beel for future use.

Table 29 shows the typical household's WTP in cash and kind toward wetland conservation. On average, each household in the neighbourhood is willing to pay Rs 68.8 per year in cash and contribute 1.7 days of voluntary work per year, which is equivalent to Rs 595 per year based on the local wage rate of Rs 350. It is

Table 25 — Cost and travelling expenses

Cost	Amount
<i>Assuming that a total of 80 to 100 visitors visits per day and 200 to 400 visitors visit on Sunday</i>	
Average number of visitors on weekdays (in no.)	
Average number of visitors on Sunday (in no.)	90
Average number of visitors per week (in no.)	300
Average number of visitors per month (in no.)	840 (6 days + Sunday)
Average number of visitors per year (in no.)	840 x 4 weeks = 3,360
<i>(Have selected 78 visitors considering two seasons. In selecting the respondent, the condition is that he should not belong to the same group.)</i>	3360 x 12 months = 40,320
Average travelling expenses for each visitor	
In-site expenditure for each visitor	Rs 159
Average expenditure on food/drinking	Rs 102
Other expenditure	Rs 43
<b>Total expenditure per visitor</b>	Rs 13
Total expenditure for 78 visitors	Rs 317
Total expenditure for 40,320 visitors	Rs 24,726
	Rs 12,781,440

Source: Survey data

Table 26 — Households (HHs) WTP for biodiversity conservation

WTP		Payment form			
Number	%	Cash		kind	
		Number	%	Number	%
399	69.2	392	98.2	336	84.2

Table 27 — Value of the conservation of biodiversity

Total households (a)	WTP (INR/Household) Total			
	In Cash	In Kind	Total (b)	(Rs/household) (a*b)
5770	80.2	735	815.2	4,703,704

Table 28 — Households WTP for the conservation of the wetland

WTP		Payment form			
Number	%	Cash		kind	
		Number	%	Number	%
374	64.8	363	97.1	292	78.1

Table 29 — Value of the conservation of the wetland for future use

Total Households (a)	WTP (Rs/household) Total			
	In Cash	In Kind	Total (b)	(Rs/Household) (a*b)
5770	68.8	595	663.8	3,830,126

seen that within the Sone Beel area, WTP in cash is lower than WTP in kind. The nonuse value would result in Rs 3,830,126 if simple extrapolation is made with some of the households in the wetland.

#### Total economic value

As shown in Table 30, the TEV of Sone Beel is estimated at Rs 561,088,074. Out of the different direct use values, especially fish products, it consists of

84.53%, followed by duck rearing, water transport, tourism, and paddy cultivation. Indirect use value and nonuse value vary negligibly comparatively with direct use values. The low indirect use value and nonuse value show the negligence of Sone Beel in the conservation and protection of biodiversity and future needs.

TEV of Sone Beel was divided by total households benefiting from wetlands to compute the value of the wetland for each household. The value of the wetland for each household is Rs 97,242.30 per year.

The total value of the wetland is Rs 561,088,074 (USD 6,769,140.46) per year or Rs 97,242.30 (USD 1,173.16) per household per year. Of the TEV, direct use value contributes to 98.48 per cent of the total economic value of the wetland. This reveals that the surrounding people have not given any importance to the conservation and management of the Sone Beel, and this will hamper future generations.

Fishing is considered the major economic activity in Sone Beel. The fishing value is estimated at Rs 474,261,153 (USD 5,721,633.57) per annum. The value of paddy production is Rs 6,977,351 (USD 84,176.93) per annum. The value of tourism is estimated at Rs 12,781,440 (USD 154199.25) per annum. Duck rearing is another profitable activity practised in Sone Beel, and the value was estimated as Rs 30,138,400 (USD 363599.00) per annum. The valuation of water transport in Sone Beel is estimated at Rs 28,395,900 (USD 342,576.94) per annum.

The results of the CVM also reveal that more than two-thirds, i.e., 69.2 per cent of the total households, are willing to conserve the biodiversity of Sone Beel,

Table 30 — TEV of products and services of Sone Beel

Value	Products and Services & Total no. of households	Value (Rs)	Proportion (%)	Value per unit Rs/HH
Direct use value	Fish	474,261,153.0	84.53	158,087.05
	Paddy	6,977,351.0	1.24	7,344.58
	Duck rearing	30,138,400.0	5.37	30,138.40
	Water transport	28,395,900.0	5.06	82,306.96
	Tourism	12,781,440.0	2.28	1,211.05
Indirect use value	Biodiversity conservation	4,703,704.0	0.84	815.20
Nonuse value	Future use	3,830,126.0	0.68	663.80
TEV	All	561,088,074.0	100.00	97,242.30

Source: Survey data

and more than half of the households, i.e., 64.8 per cent, are willing to conserve the nonuse or future use value of the resources of Sone Beel. The value for the conservation of biodiversity is estimated at Rs4,703,704 (USD 56,746.94) per annum, and the value for nonuse or future use value of resources of Sone Beel is estimated at Rs 3,830,126 (USD 46,207.83) per annum.

The study provides an average estimation of the economic benefits of the PAS of the wetland. The study results revealed that fishing is the major contributor to the TEV of direct use values of Sone Beel, followed by duck rearing, water transport, paddy cultivation, and tourism. The study further revealed that the fishing communities, for generations, have directly depended upon this wetland for their livelihood and mostly depend on traditional fishing practices.

### Conclusion

The present study focused on five important PAS of Sone Beel relevant to the current conservation strategy. However, further researchers can explore different attributes to estimate the economic benefits of wetland improvement and enhance conservation efforts. Furthermore, it is crucial to involve locally educated young individuals in wetland-based activity, especially in the tourism sector, offering them income-generating opportunities to sustain their livelihoods. Hence, it is imperative to modernize the management of the wetland and recreational facilities to attract more visitors. This increase in visitor numbers would result in a higher monetary value for the wetland. The percentage of people interested in WTP for biodiversity conservation and conservation for future use in the CV survey can be a valuable asset for policymakers in mobilizing funds to support the expenses associated with the conservation and improvement of the wetland.

### Conflict of interest

The authors have no conflict of interest to disclose.

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