Summary Report

Hail Haor Wetland:
Estimation of Economic Value

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Management of Aquatic Ecosystems through Community Husbandry (MACH) Project

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Acronyms / Abbreviations

ADB	Asian Development Bank
BCAS	Bangladesh Centre for Advanced Studies
BSF	Beneficiary Survey Form
CBO	Community Based Organization
CDI	Caritas Development Institute
CNRS	Center for Natural Resources Studies
FTF	Farmer to Farmer (program)
GIS	Geographical Information System
GOB	Government of Bangladesh
MOFL	Ministry of Fisheries and Livestock
MOL	Ministry of Land
NGO	Non Governmental Organization
PM&E	Participatory Monitoring and Evaluation
PRA	Participatory Rural Appraisal
TOR	Terms of Reference
TA	Technical Assistance
USAID	US Agency for International Development

Executive Summary

The MACH Project

The MACH project is an innovative integrated pilot program to develop approaches and to demonstrate sustainable management of water resources including fish, plants, agriculture, livestock, forestry, and wildlife over entire wetland ecosystems. Wetlands in Bangladesh provide a critical source of income and nutrition for millions of rural Bangladesh's poorest people. Unfortunately, the productivity of these habitats is in decline due to over-use, increased rates of sedimentation from watershed degradation, pollution, diversion of water for agricultural uses and the conversion of wetlands for agricultural and urban development.

MACH takes a multi-disciplinary participatory approach to address wetland decline. MACH is pioneering a variety of activities to reduce over use of wetland resources and to preserve wetland resources from degradation in selected project sites. Examples of these activities include development of fish sanctuaries, alternative income programs to reduce seasonal pressures, reforestation of tributaries to reduce sedimentation and reconnecting water bodies to preserve wetland productivity. The MACH approach includes close integration of project initiated resource user committees with local government structures to ensure sustainability.

MACH is a GoB project that is being implemented by four non-government organizations, Winrock International, the Bangladesh Centre for Advanced Studies (BCAS), the Centre for Natural Resources Studies (CNRS) and CARITAS-Bangladesh with support from USAID. Currently the program is working at three sites that are representative of the freshwater wetland ecotypes of Bangladesh (**Figure 1**). This study was conducted in the Hail Haor MACH site in Moulvibazar District. Hail Haor is an extensive wetland area that reaches a maximum flooded size of 12,300 hectares (1999 measurement).

The Study

This study has been undertaken to develop a methodological framework and to calculate an estimate of the economic value of the MACH Hail Haor wetland site centered in Moulvibazar district. The estimated value in this study should be considered a conservative lower bound on the wetland's economic value. Estimation of wetland value is an important and complex task that has not been tackled systematically in Bangladesh. To justify water resource preservation and investment to improve productivity it is important to establish that sustainable management of water resources results in the generation of economic value that exceeds the economic value produced under alternative arrangements.

Wetland areas produce a wide variety of economic benefits. Some benefits can be more readily identified and quantified than other benefits. Direct benefits such as fisheries production, production of aquatic vegetation and products can be estimated from sample surveys and monitoring of beneficiaries. Other benefits such as recreational value, flood control value, water quality improvement, pasture value, biodiversity, water table impacts, have real and very significant economic value but are much more challenging to estimate. Failure to include the economic value of all wetland outputs has clearly biased development efforts in Bangladesh towards conversion of wetlands to agricultural use and to neglect of wetland areas.

To facilitate application of the approaches developed for this study a **bioeconomic model** was developed. The bioeconomic model is an Excel based application that will be a tool for

researchers and practitioners to understand, refine and extend the economic analysis performed for this study relating economic and biological parameters.[1]

Results

The annual economic output value estimated for Hail Haor is Tk 454 million (USD 8 million). The net present value of this benefit stream over 15 years is Tk 4.7 billion (USD 83 million).[2] **Table 1** presents the net annual value of nine selected Hail Haor wetland economic outputs (see **Chapter 2.0 and 3.0** for details). Value is presented in both absolute terms for Hail Haor and per hectare of the Hail Haor maximum area. It should be noted that the per hectare values are for the total Hail Haor output divided by the maximum Haor area. For this calculation the recorded 1999 maximum water area was used (12,300 Ha).

Table 1: Annual value of estimated Hail Haor economic outputs.

Hail Haor Returns	Total Returns (Taka)	Current Returns (TK /HA)*	Percent
Commercial Fisheries	56,272,221	4,575	12.4%
Subsistence Fisheries	83,651,052	6,801	18.4%
Non fish products	126,056,499	10,248	27.7%
Recreation	7,025,634	571	1.5%
Flood Control	23,443,167	1,906	5.2%
Tea estate vegetation use	1,916,761	156	0.4%
Project / Biodiversity Funds	43,650,600	3,549	9.6%
Transportation	8,758,318	712	1.9%
Pasture value	40,292,840	3,276	8.9%
Boro rice value	63,857,500	5,192	14.0%
Water quality	Not Done	Not Done	
Aquifer charge	Not Done	Not Done	
Existence values	Not Done	Not Done	
Total (Tk)	**454,924,591**	**36,986**	**1**
Total USD	**$7,981,133**	**$649**	

* This figure is total output value divided by total Haor area (12,300 Ha recorded in 1999).

Commercial fishing represents 12.4% of total value and subsistence fishing accounts for 18.4% of the annual Haor value. Significantly the annual value of non-fish aquatic products including aquatic grasses, plants for human consumption, snails, mussels and other products is 28% of the total value. This is the largest single economic output. The importance of dry season pastureland is also very significant at 9% of total value. The share of value for recreation and flood control are 2% and 5% respectively. It should also be noted that the current value of boro rice produced within the Haor wetland area is included (Tk 63 million). The foreign project investment attributed to biodiversity preservation is Tk 43 million (9.6%). This represents the discounted value of the MACH project investments and likely foreign development assistance to be provided to Bangladesh due to the biodiversity aspect

[1] An electronic copy of the bioeconomic model can be obtained by emailing Dr. Luke Colavito at Lcolavito@winrock.org or Dr. Darrell Deppert at ddeppert@winrockbd.org.

[2] NPV was calculated for the 15-year period based on a real inflation adjusted interest rate of 5%. See Chapter 2.0 for a discussion of NPV.

of the Hail Haor wetland. A number of foreign aid programs and efforts (IUCN, ICLARM, DFID, and Danida) include a strong emphasis on investment for biodiversity preservation.

The estimated annual values for the wetland economic outputs are very conservative. They are conservative because important economic outputs such as water quality improvement and aquifer charge were not included but represent very significant economic outputs. It should also be noted that the Hail Haor has already been substantially degraded from over use, loss of water body connections, water diversion, pollution, conversion to boro rice, and sedimentation from mismanagement of the surrounding watershed. This means that the value of wetland economic outputs would be much greater for a healthy ecosystem managed sustainably.

Table 2 presents the value of output for specific category groupings of economic outputs. It is significant to note that both overall value per Ha Tk 37,00 (**Table 1**) and returns to wetland natural outputs Tk 31,794 exceeds the value of Boro rice production Tk 18,254 per Ha (BBS 1999). This strongly shows that maintaining and improving management of wetland resources offers higher economic benefits than conversion of wetlands to boro rice production. It should also be noted that this comparison is done on the basis of net economic returns. It was beyond the scope of this study to estimate value addition by each economic output. However, the value added from Haor economic outputs will exceed boro rice value added because boro rice cultivation requires costly inputs (fertilizer, seed, own land, and other chemicals) while harvesting for the majority of hoar outputs requires very little capital and cash cost.

Table 2: Hail Haor economic value by output groupings.

Groupings	Current Total Returns (Taka)	Current Returns (TK /HA)*	Comments
(1) Returns to wetlands	391,067,09	31,794	Returns without Boro rice value
(2) Returns to wetlands (no Biodiv)	347,416,491	28,245	Returns without Project Funds and Boro
(3) Returns with no BioDiv Funds	411,273,991	33,437	Returns without Project Funds

The economic returns to the MACH project were also estimated utilizing the bioeconomic model. **Table 3** presents the key parameters and results of this analysis. The parameters used were highly conservative. It was assumed that the project would bring into place an annual increase in productivity for natural resources of 2% per annum and prevent a degradation of 3% per annum over the next 15 years. Based on these conservative estimates of productivity improvements the **B/C ratio is 7.4 and the IRR is 63%** for the MACH Hail Haor investment. An IRR of 63% for a project tasked with developing approaches to improved wetland management is highly significant.

Table 3: Returns to MACH Hail Haor investment.

Parameters:	Annual Project Caused Increase %*	Annual Project Caused Loss Avoided %*
Fisheries	2%	3%
Non fish products	2%	3%
Recreation	5%	0
Results		
B/C	4.1	
IRR	41%	

Note: Time horizon 15 years, MACH investment 2.2 million (USD), with a one-year delay in benefits.

Summary of Recommendations

Based on this conservative estimate of Hail Haor wetland value a number of recommendations are indicated. Policy recommendations stemming from the study include (See **Chapter 4.0** for details):

- **Preservation.** This study provides a basis for wetland preservation because of higher productivity than alternative agricultural uses. This is indicated by the higher per hectare productivity for the Hail Haor wetland than for alterative Boro rice production. It should be noted that this recommendation is for broad preservation of the Hail Haor wetland. The model is not sufficiently detailed to make micro recommendations concerning marginal conversion of wetlands to boro rice production and vice versa.

- **Investment.** This study indicates high potential returns to investment of development resources to rehabilitate wetlands. Returns to very modest increases in wetland productivity are demonstrated to have large economic impacts. Economic benefits from wetlands also benefit disproportionably poorer segments of society contributing to national poverty alleviation goals.

- **Watershed preservation.** Consequent to the above recommendations it is crucial that watersheds surrounding wetland areas be sustainably managed to control erosion and other negative impacts. Sustainable management of watersheds will have inherent economic benefits and result in preservation of wetland productivity.

- **Social Mobilization and Institutions.** The study results show that wetland economic benefits accrue from diverse sources (nine benefits were quantified). Some of these benefits are also not even fully recognized by recipients (e.g. flood control, water charge, development assistance). To preserve and increase the productivity of wetland outputs social mobilization and institutions are required to organize beneficiaries to press for preservation of resources, investment to improve productivity and to organize sustainable management practices to limit over exploitation of resources.

- **Recreational Use.** It should be stressed that survey research to estimate the value of recreation indicated substantial returns to local tourism and scope to increase recreational use of the Haor. Currently there are no programs or organized activities to attract tourists to the area aside from limited programs at Teas Estates.

Recommendations for extension of the bioeconomic model and research to support sustainable development of wetland resources in Bangladesh include.

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- **Extend research base.** MACH should utilize the methods and the bioeconomic model to estimate the value of wetland economic outputs for other project sites and for the boro haor[3]. MACH should also seek collaboration with related fisheries and natural resource management projects to conduct such estimation. Establishment of a broader base of results will build the case for policies to preserve and enhance the productivity of wetlands. Estimation of economic value for wetlands in different states of degradation will also yield insights into wetland health and productivity. The models can also be updated for specific wetlands across a number of years to develop a time series that can indicate productivity variation and trend.

- **Identify and Estimate Additional Benefits.** Methodologies should be developed to estimate the economic value of outputs not quantified in this study. Those approaches should be incorporated in the bioeconomic model. It is particularly important to estimate the impact of the Haor on aquifer charge. This is a potentially large economic value since significant agricultural production and drinking water in the area depend on ground water.

- **Modeling Project Interventions.** To more accurately estimate the returns to specific project interventions and justify those interventions estimates should be made for the impact of specific interventions such as fish sanctuaries, reconnection of water bodies, reducing harvest level of effort on wetland productivity.

- **Develop and integrate a watershed bioeconomic model with the wetland model.** The health of wetlands depends on the health of their surrounding watersheds. For Hail Haor there are clear indications that mismanagement of land resources in the watershed is resulting in excessive erosion that threatens to seriously degrade the wetland. To estimate and justify efforts to establish sustainable management in the surrounding watershed a bioeconomic model of a similar type should be developed and integrated with wetland model.

- **Watershed Erosion Modeling.** To develop the integrated model and to determine the potential destructive impact of soil erosion on the health of the Hail Haor wetland it is crucial to model surrounding watershed erosion. This modeling effort should include determining the relative causes of erosion (e.g. poor agricultural practices, deforestation, other) and the effect of excessive erosion on Hail Haor water depth of erosion over time.

- **Additional Analysis.** In the course of conducting this study and associated surveys additional data was collected on a variety of topics. Specific topics for which analysis of collected should be conducted include: (1) Analysis of tourism patterns and potential in Hail Haor, (2) Detailed analysis of the products and user types of non aquatic vegetation including impact on poverty alleviation, (3) Examination of resource productivity by state of local beels/habitat.

[3] Partial data has been collected for estimation of the economic output from the boro haor, which is close to he Hail Haor site.

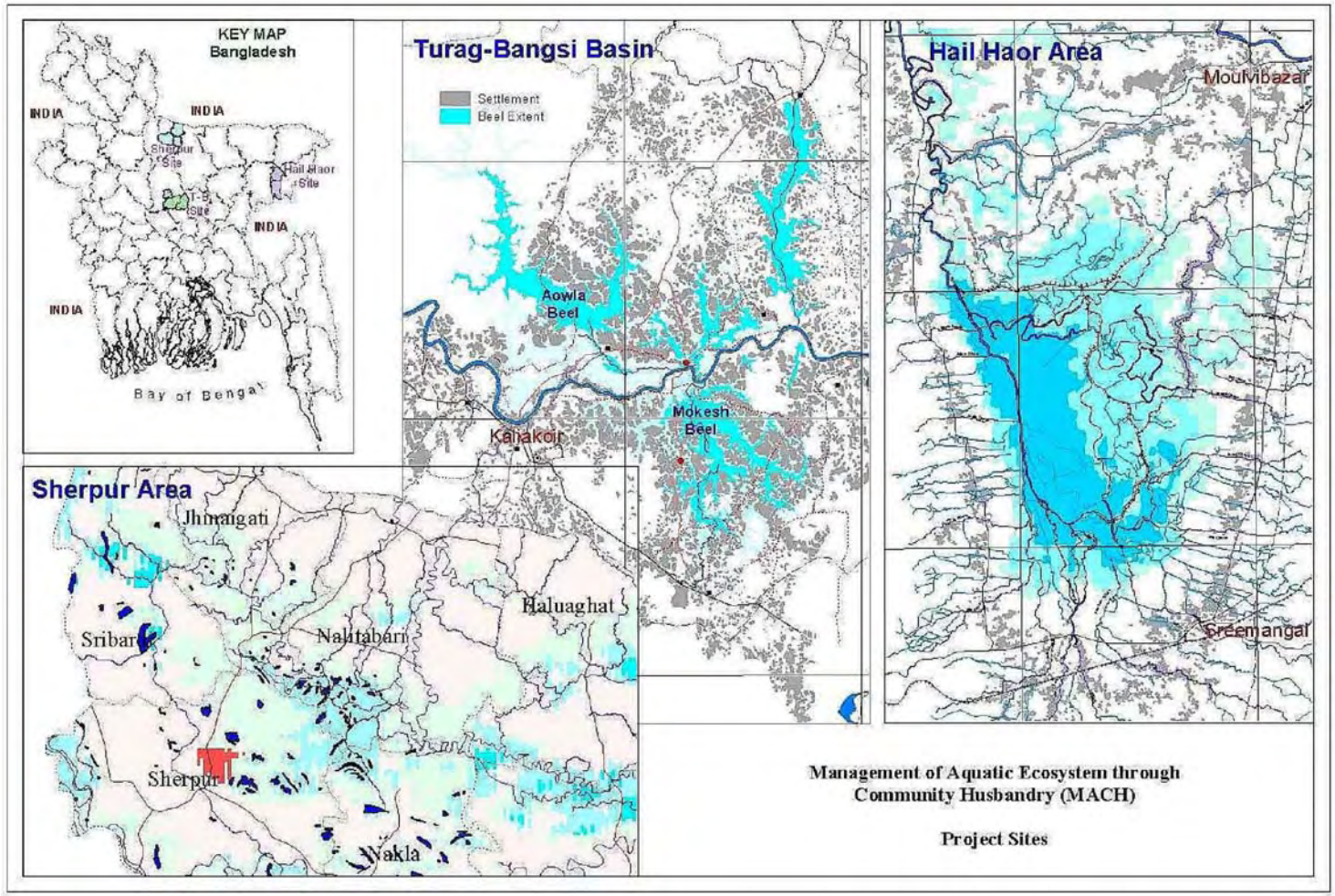

Figure 1: MACH Project sites

1.0 Introduction

The floodplains of Bangladesh provide a critical source of income and nutrition for millions of rural Bangladesh's poorest people. These wetlands are home to hundreds of species of unique plants, fish, birds, and other wildlife. They are also important habitats for thousands of migrating birds. Unfortunately, these habitats are in decline due to over-use, increased rates of sedimentation, and the conversion of more and more wetlands to agriculture and urban development to meet the demands of a growing population.

MACH is a Government of Bangladesh (GOB) program supported by USAID. The major purpose of the project is to demonstrate to communities, local government and policy-makers the viability of a community approach to sustainable natural resource management and habitat conservation over an entire wetland ecosystem. The MACH 'community' includes those people who dependant, either economically or nutritional on wetland products. The program emphasizes and works with poorer individuals and groups, particularly fisher communities who are generally the poorest members of rural society. However, the program is closely integrated with local government institutions and elites to develop viable approaches to introducing sustainable management solutions.

MACH is currently working at three sites that are representative of the freshwater wetland ecotypes of Bangladesh: (1) Hail Haor in Moulvibazar District, (2) the lower Bangshi/Turag River Basin in Gazipur and (3) Taingail District. MACH is being implemented by four non-government organizations, namely Winrock International, the Bangladesh Centre for Advanced Studies (BCAS), the Centre for Natural Resources Studies (CNRS) and CARITAS-Bangladesh.

A National level Steering Committee was formed in November 1999. The committee is chaired by Secretary Ministry of Fisheries and Livestock and vice-chaired by the Joint Secretary, Ministry of Land. The steering committee provides guidance and advice to the project and in addition, is responsible for approach of project sites and review of annual workplans. An integral part of the MACH Project Management at all sites is the MACH Upazila level Local Government Committee (MACH-LGC). The committees allow local government a voice in project activities and sure their support for the agreed to project initiatives.

1.1 Project Objectives

MACH is working to ensure the sustainable productivity of all wetland resources – water, fish, plants and wildlife over an entire wetland ecosystem (beels, seasonal floodplains, wetlands, river/streams), not just a single water body. The MACH approach requires that all factors affecting the communities and their wetland resource be considered. MACH advocates a multi-disciplinary, multisector and participatory process of planning, implementation and monitoring for sustainable wetland resource management. Recognizing that the reduction of fishing level of effort is likely to be critical part of reviving the wetland fisheries.[4] MACH has included supplemental income-generating activities that will be focused on those directly dependent on fishing.

[4] It should be noted that for an over exploited fishery a reduction in catch effort will in fact increase total yield.

Key elements of the project are:

- Participatory wetland resource and problem assessment
- Wetland and watershed habitat restoration and management
- Biodiversity conservation and enhancement
- Resource management committee formation and integrated wetland resource planning and management
- Beneficiary group formation and strengthening to include alternative or supplemental livelihood development and credit program for disadvantaged wetlands resource users
- Participatory resource use zoning to be used in part to establish limited access regimes such as sanctuaries
- Skill training in integrated wetland resource management including cross-visits by beneficiaries to successful areas
- Awareness building through information, education, and communication
- Leveraging support and creating synergy with other projects to boost impact
- Develop mechanisms for effective awareness building and policy strengthening at the national level
- Baseline fish catch and household survey
- Community and MACH impact monitoring and evaluation
- Policy guidance through awareness seminars, directives from the local government committees and the formation of high-level project support forums.

1.2 Study Objectives

The objective of the assignment is to develop a methodology to determine a lower limit on the economic value of the Hail Haor MACH project site. Currently, the Hail Haor wetlands is in a degraded state and is its condition is continuing to decline due to siltation caused by man made erosion in the surrounding hills and overexploitation of common resources. The assignment approach will be to evaluate the condition of the wetland ecosystem (including the surrounding watershed) in future states without project rehabilitation and preservation efforts and with project interventions and scenarios for their impact.

Establishment of the economic value of wetlands is crucial to justify their preservation and to justify the allocation of resources for their management. In order to justify preservation and management of wetlands it is crucial to demonstrate that the economic value of wetlands exceeds their use as converted agricultural land or poorly managed marginal overexploited areas.

A key assignment deliverable will be the development of a computer application based bioeconomic model that will be a tool for researchers and practitioners to refine and extend the assignment economic analysis. The goal will be to provide a methodology and baseline framework to analyze the economic value of wetlands and improved wetland management. The consultant will develop data collection methodologies and work with MACH partners CNRS and BCAS to model the Hail Haor economic outputs.

The developed bioeconomic model will also facilitate the economic valuation of different project interventions including:

1. Decreasing siltation from the surrounding watershed through re-vegetation of streams feeding the Haor and promotion of alternative agricultural practices;
2. Developing sanctuaries, management systems, and alternative income sources to decrease over harvesting of natural resources;
3. Rehabilitating wetlands; and
4. Reconnecting beels and the river system to Hail Haor;

Hail Hoar found in Molvibazar District is a large basin surrounded by low hills on three sides. The Haor receives water flowing out of many small streams draining the hills. It becomes a large single body of water of approximately 13,000 ha in the rainy season and is reduced to several small waters of 2,000-3000 ha in the dry seas. This is representative of Sylhet hoar basin.

2.0 Methodology

2.1 Introduction

The overall approach taken for the estimation of the Hail Haor wetland economic benefit is essentially a careful accounting of the annual value of various economic outputs. Specific methodologies are detailed for each economic output. In general basic methods relying on household surveys, rapid rural appraisals (RRA), key informants, and MACH project monitoring and evaluation data were utilized. The stream of annual benefits is then utilized to calculate the internal rate of return (IRR) from wetland preservation and management activities. Economic benefits will be estimated under the following standard classification scheme of wetland benefits[5]:

Private Values - These are economic values of products generated from the wetlands (direct benefits) including:

1. Fisheries harvest; and
2. Harvesting of aquatic non-fish products.
3. Land use for pasture and boro rice

Public Values – These represent public goods generated from the wetlands and include:

1. Flood control
2. Recreation
3. Biodiversity
4. Transportation
5. Aquifer charge
6. Water quality

The economic output evaluated is the amount of gross revenue generated by primary activities associated with Hail Haor wetland resources. This follows standard practice. An attempt to estimate value added by activity and alternative activities was not attempted. However, it should be noted that since Hail Haor outputs are either resource extraction or public values the share of value addition will in fact exceed alternative agricultural production activities. This implies that the estimation of relative Hail Haor value is conservative.

It should be noted that the private benefits listed with the exception of boro rice are derived from a **common property resource**. A common property resource is one for which access either to the general public or more narrowly a selected group of surrounding users is open. Hardin nearly 30 years ago expressed the ***tragedy of the commons***. The ***tragedy of the commons*** refers to the incentives of individual users to over exploit common resources because they do not factor in the reduction in resource productivity for other users. This means that yields from common property resources are sub-optimal. For the Hail Haor this means that a reduction in the level of effort of resource extraction would in fact result in higher absolute yields. To overcome the tragedy of the commons institutions and social mobilization are required to reduce the level of effort for resource extraction.

[5] It should be noted that not all economic outputs listed will be evaluated for this study.

The public values refer to a positive externality produced by the wetland. These benefits may well not be fully perceived by beneficiaries. For example local residents may be unaware that the wetlands are acting to maintain the health of the local aquifer, reduce flood severity, and improve water quality.

To identify Hail Haor economic benefits and develop methodologies to estimate the value of the benefits a field trip to the site was undertaken by the consultant facilitated by local MACH project staff. The visit was instrumental in understanding the economic outputs of Hail Haor. **Table 2.1** describes the activities undertaken during the visits and a description of the activities and some general findings.

Table 2.1: Field visit activities.

Activity	Description/outcome
Visit to Hail Haor wetland	• Team took boat tour of hail haor to determine physical layout including an understanding of land use for pasture/dolkhulmi and boro rice
RRA with fisherman	• Met with local fisher group to understand economic benefits from Hail Haor. It was found that a surprising amount of non-fish aquatic material was being harvested.
RRA with farmers	• Met with two local farmer groups to understand economic benefits from Hail Haor and neighboring Boro Haor. It was found that farmers harvested a surprising amount of both fish and non-fish aquatic material was being harvested.
Visit to Tea Research Institute	• Met with specialists at the Bangladesh Tea Research Institute. It was found that Tea Estates were harvesting significant amounts of water hyacinth for mulch. It was also found that tea estate use of herbicides/pesticides was significant and that some practices such as removing vegetation from tea ditches contributed to erosion.
Visit to Bangladesh Water Development Board	• From the visit to the Bangladesh Water Development Board a proposal for a Hail Haor Flood Control Scheme was obtained
Visit to District Forrest Office	• From the meeting at the DFO and subsequent tour land use patterns for tea, lemon, pineapple, forestry and other uses were investigated.
Visit to District Fisheries Office	• Little information was available at the District Fisheries Office. Systematic time series data on fish yields was not available.
Visit to Local Hotel	• The hotel owner indicated that significant numbers of domestic and foreign tourists were visiting Srimongel and surrounding areas.
Visit to MACH stream re-vegetation scheme	• The program for re-vegetating tributaries to the Hail Haor was observed. The approach pointed to the need for local institutions to develop and manage such efforts.
Visit to Pineapple / lemon Growers	• Met with a group of pineapple and lemon growers. Pineapple farmers on lease systems were using vertically sown rows with led to soil erosion. Farmers noted that yields declined 50% over 5 years. Since these farmers a leasing land they are not internalizing the cost of soil erosion.
Visit to Betel Producers	• Met with a group of Betel Producers who sustainable harvesting betel within forested areas

Activity	Description/outcome
Visit with Caritas Income Generation Group	• Met with Caritas income generation group. Group also confirmed that they were harvesting larger amounts of materials from Hail Hoar
Discussions with Project Staff	• Extensive discussions were held with local staff concerning observations from the field visits, the geography of the Hail Haor, and approaches to estimating economic outputs.

A variety of approaches and information gathering activities were developed and conducted for estimation of Hail Hoar benefits. Specific surveys were developed for households surrounding Hail Haor to estimate non-fish aquatic product usage, for hotels and tourists for recreational value, and RRA checklists were developed for a variety of economic outputs. **Table 2.2** provides a brief summary of the specific approaches used to estimate the value of Hail Haor economic benefits. Details are provided in the respective sections below.

Table 2.2: Summary of economic output approaches.

Economic Output	Estimation Approach
1. Fisheries	The data collected by the on-going sample monitoring system was utilized. MACH on a monthly basis estimates fish yield for four water classifications. Per HA data was then scaled up utilizing GIS estimates of water area.
2. Non fish products	A stratified sample HH survey was conduced in villages surrounding Hail Hoar. Results were scaled up based on total population of the surrounding villages.
3. Recreation	The value of tourism to the region was partially attributed to the Haor. Data on tourist expenditure patterns was collected through surveys of Hotels and tourists
4. Flood Control	A cost avoidance approach was used. The cost avoided was given by a proposed WB flood control scheme proposed for the Haor.
5. Tea estate vegetation use	Tea estates use water hyacinth as mulch. An RRA of selected estates was conducted to estimate per HA consumption. Estimates of total tea estate area were used to blow up the results.
6. Project / Biodiversity Funds	Key Informants provided information on the value of MACH and other potential projects to be partially targeted because of the Hail Haor. The annual valuation of these investments was then calculated.
7. Transportation	An RRA survey was conducted at key boat launching sites.
8. Pasture value	The area of pastureland was estimated by deducting the area of boro rice and utilizing the GIS database to determine pasture area. An extremely low value of per HA pastureland was then used to scale up.
9. Boro rice value	Similar to No. 8 above area was estimated and a standard value of boro rice production was used.
Water quality	Was not estimated but will be a significant value as the Haor acts to purify water through natural processes.
Aquifer charge	Was not estimated but will be a very significant value as the Haor acts to maintain the charge of local aquifers that provide critical drinking and agricultural water
Existence values	Existence values beyond the tourists visiting the area were not estimated.

The study defined the area of Hail Haor as the maximum area flooded at the peak point in the year. This was estimated by the MACH project GIS Database for a full year between 1999-2000. This areas was estimated be 12,300 Ha. **Table 2.3** details water area by water type in Hal Haor.

Table 2.3: Hail Haor wetland area.

Month	River Gopla (ha)	Flood Plain (ha)	Beel and Hoar Area (ha)	Canal Area (ha)	Total Area (ha)
January	150	1445	3025	180	4800
February	150	655	3025	170	4000
March	150	0	3025	170	3345
April	150	455	3025	170	3800
May	150	5425	3025	200	8800
June	150	8905	3025	220	12300
July	150	8605	3025	220	12000
August	150	8465	3025	210	11850
September	150	8265	3025	210	11650
October	150	6925	3025	200	10300
November	150	4935	3025	190	8300
December	150	2245	3025	180	5600
Max Area	**150**	**8905**	**3025**	**220**	**12300**

Source: BCAS GIS database (1999-2000).

The study objective is to identify and to the extant possible quantify all the economic benefits arising from within the 12,300 Ha area defined as Hail Haor. It should be noted that since boro rice and pastureland is also produced within the 12,300 Ha area their economic value was also included. The economic valuation can be through of as the value of the Hail Haor wetland in its current configuration and management system.

To facilate application of the approaches developed for this study a **bioeconomic model** was developed. The bioeconomic model is an Excel based application that is a tool for researchers and practitioners to refine and extend the assignment economic analysis performed for this study. It also allows sensitivity analysis of results and calculation of IRR for project investments. Selected bioeconomic model spreadsheets are provided in **Annex B**. Interested professionals are encouraged to obtain the model from the MACH project and utilize it for evaluation of wetland management activities.

The model does not have embedded data on the relationships between productivity and different land uses (e.g. what would the impact of more boro rice land conversion on fisheries productivity) but does

2.2 Fisheries

The MACH project has implemented an extensive fish yield monitoring program in its project sites. The monitoring program measures all fish yield on specific water type areas of

Hail Haor. These areas are sampled for yield on a monthly basis. Yield is estimated in per hectare terms. The water type classifications are flood plain, beel, river, and canal. Full technical details on the monitoring system are given in the MACH monitoring protocols document. Annex B provides the data tables for fish production integrated in the bioeconomic model.

To estimate overall fish yield the MACH GIS database was utilized. By month the area of the four water types was estimated through the GIS database. Yields were then scaled up by multiplying per Ha species results by the area of the water type. Economic valuation was then applied by multiplying average yearly price by the amount of fish production.

There is reason to suspect that the MACH monitoring approach may actually underestimate the fish yield. The approach may underestimate the amount of fish captured by shore based farmers and part time fishers. These users have no boats and limited equipment. Their yield may be underestimated for two reasons (1) They are not as visible as boat based fishers and and (2) the catch monitoring areas contain proportionally less shoreline than the entire Haor. The fact that fish yield estimation is too low means that the estimate of fisheries output value is conservative.

One important technical note is that the value of beel leasing both in terms of fees paid to the government by beel lessees and fees paid by fisherman to leases were not included in the estimation. These fees do not represent an economic output of the Haor. This study does not attempt to look at the relative taxation between Haor wetland outputs and alternative land uses.

2.3 Non Fisheries Harvested Products

Farmers near Hail Haor are extracting a wide variety of products from the Haor and these products have very significant value. Agricultural users also travel significant distances up to 2 km to reach the haor indicating that the number of such users is very high. Agricultural users also reported extensive fishing during the wet season. A total of 13 main non-fish products were recorded in a random sample survey of users, the time spent in collecting these, average harvests and values for these products were all obtained through interviews.

2.4 Recreation

Significant use of the Hoar watershed area by tourists was reported. Two surveys were conducted – a hotel manager survey top estimate the volume of visits, their expenditures and activities; and a visitor survey that also recorded willingness to pay to preserve the haor.

2.5 Flood Control

A standard cost avoidance approach was used to estimate the value of the wetlands for flood control. The logic of this approach is that flood control structures would be needed for either off two alternative Hail Haor futures. If the surrounding watershed is allowed to continue to degrade and erosion continues unabated Hail Haor's ability to absorb floodwaters will be decreased and flood control measures will be required. Alternatively if substantial land were to be converted to boro rice control structures would be required to control flooding of water on to the boro rice area and beyond.[6]

Conveniently the Bangladesh Water Development Board (BWDB) developed and submitted a proposal for World Bank loan funding of a flood control scheme in 1996 for Hail Haor. The costs for this scheme were updated using current prices and utilized in the bioeconomic model to estimate the annual value of Hail Haor flood control. Costs were annualized by amortizing capital costs (see box below).

Financial Calculations

It should be noted that for the flood control scheme and other outputs that involve capital costs amortization was used in the bioeconomic model to estimate annualized cost. The annualized cost of a capital item is determined as the cost of servicing a loan for the cost of the capital item over the expected life of the item. Operationally this is preformed in the bioeconomic model by using the Excel PMT function. Syntax:

- PMT(rate,nper,pv,fv,type)
- Rate is the interest rate for the loan.
- Nper is the total number of payments for the loan.
- Pv is the present value, or the total amount that a series of future payments is worth now (principal).
- Fv is the future value, If fv is omitted, it is assumed to be 0 (zero), that is, the future value of a loan is 0.

The payment returned by PMT includes principal and interest but no taxes, reserve payments, or fees sometimes associated with loans. Microsoft Excel solves for one financial argument in terms of the others. If rate is not 0, then:

$$PV \bullet (1+Rate)^{nper} + PMT(1+Rate) \bullet \left(\frac{(1+Rate)^{nper} - 1}{Rate} \right) + FV = 0$$

If rate is 0, then:

$$(PMT) \bullet nper) + PV + FV = 0$$

NPV

Net present value is used to estimate the current value of a stream of financial benefits for a given period at a given interest rate. In this study a real interest rate of 5% is used. This represents the inflation adjusted inflation rate.

IRR

The Internal Rate of Return is an interest rate at which an investor would be indifferent from a given stream of income. It is standard to use IRR to rank and judge project feasibility. It should be noted that this return is in reference to the investing generation and does not include factoring undiscounted benefits of future generations from the investment.

(Postscript – it is likely that this proposal aimed to change landuse in the haor rather than to protect from flood damage those existing land uses that would be more vulnerable without the haor. Consequently the figure used is only a rough approximation to the flood damages that are averted by water storage in the haor, but no alternative figure can readily be estimated.)

2.6 Tea Estate Vegetation

[6] Alternatively the flood control structures should be viewed as a cost of production for boro rice.

It was also reported that Tea estates were extracting vegetation from the Haor to use as mulch/manure. Three estates were reported to do this, key informants were interviewed to find out the amounts and cost of water hyacinth that they collect.

2.7 Biodiversity

As a proxy indicator for the value of wildlife in the haor catchment an appropriate proportion of the probable USAID grants towards their protection through projects was annualized. Note that this is a very approximate method as there are multiple objectives of these projects of which biodiversity conservation is one, and the project value may not represent the value to US and Bangladesh society of these non-consumable natural assets.

2.8 Transport

Focus group discussions were held to estimate the number of boats operating on the haor, their value (annualized) the number of people working and daily wage rate.

2.9 Pasture and Boro Rice

The MACH GIS was used to estimate by month the area of boro rice and of fallow land within the total haor. Secondary data was used to estimate a monthly return from fallow land as grazing, while the net return from boro rice was used for the 3,500 ha estimated to be under this crop.

2.10 Limitations and Study Issues

There are important limitations that prevented a full economic valuation of Hail Hoar wetland economic output. Not all benefits were identified in this study and not all economic benefits identified were quantified. This results in a substantial underestimation of Hail Haor economic output and value. **Table 2.4** details the outputs not modeled and the reasons those benefits were not modeled.

Table 2.4. Hail Haor economic benefits not model.

Output	Implication / Reason not modeled
Aquifer Discharge	• The Hail Hoar wetland serves to charge the local aquifer. If Hail Haor were degraded through siltation or conversion the loss of this natural function would increase the depth of the water table and reduce water available to agricultural and human use. Currently the project does not have the capability to model the hydrologic effect of Hail Haor degradation. The value of this economic output will be very significant.
Water quality	• Natural processes of the Hail Haor wetland improve the quality of Hail Haor water. This has an economic impact on the productivity of connected water bodies and users of Hail Haor water. Currently MACH is unable to model the degree to which water quality is improved and the subsequent impact of that improvement.
Off site environmental contribution	• Hail Haor provides a habitat to a variety of wildlife such a migratory birds and fish that migrate to other habitats/sites. Destruction of Hail Haor would reduce the productivity / value of such related habitats.
Soil Fertility	• Hail Haor deposits rich silt on surrounding land as it recedes. A

	smaller wetland would provide a reduced level of such a fertility impact.

It should be noted that existence values were not included in the valuation. In some valuation exercises a value is imputed to individuals who derive a benefit from knowing that a particular natural resource exists. For Hail Haor it would be plausible to impute that existence has a value to both foreign and domestic individuals. However, this value was not included because these would be value for wealthier domestic individuals and the existence valuation of foreigners (other than what they actually expend) should not be included in a GoB utility function.

All effort was made to ensure that the estimated Hail Haor wetland value is conservative. This included the exclusion of existence values and the selection of conservative parameters in all cases. This conservative estimation allows for a stronger comparison between actual returns and returns for alternative uses such as conversion to agricultural land.

It should also be stressed that Hail Haor has been substantially degraded from over use, loss of water body connections, conversion to boro rice, and sedimentation from mismanagement of the surrounding watershed. This means that the value of wetland economic outputs would be much greater for a healthy ecosystem managed sustainably. As noted in the introduction to Chapter 2.0 this stems from the tragedy of the commons where individuals have incentives to overexploit common property resources. Under these conditions a reduction in harvest effort will increase yield in absolute terms.

An important limitation of the effort is the inability to model in detail alternative management scenarios of the Hail Hoar. However, in lieu of a detailed evaluation the value of boro rice production can be used as base value for comparison.[7] It is difficult to evaluate alternative management scenarios for the following reasons:

- Continued erosion in the Hail Haor watershed due to poor land management practices leads to siltation and fill in of the Haor. Currently erosion data collected by the project have been collected for only one year and land usage data in the watershed are not sufficient to fully associate erosion with land use practices.[8]
- Modeling of alternative scenarios will require a watershed approach as watershed health is crucial to the health of the haor and data for alternative watershed land management practices are not yet developed
- MACH interventions to improve Haor productivity are just starting and their impact on productivity is not well understood.

[7] The original TOR (See Annex A) called for an attempt to estimate alternative land use scenarios but upon investigation it was found that both data was lacking and that this would require effort beyond that allocated.
[8] The consultant will detail recommendations on how erosion control may be modeled.

3.0 Results

The annual economic output value estimated for Hail Haor in this study is Tk 348 million (USD 6.1 million). The net present value of this benefit stream over 15 years is Tk 3.6 billion (USD 63.9 million).[9] The NPV of one Ha is Tk 294,000 (USD 5,198). **Table 3.1** presents the annual value of nine selected Hail Haor wetland economic outputs and a brief description of the approach used for each estimation. Value is presented in both absolute terms and per hectare of Haor. For this calculation the 1999 maximum Haor size was used (12,300 Ha). Overall annual economic value produced from the Haor is Tk 348 million of which 121 million (35% of total value) derives from fisheries. Significantly the annual value of non-fish aquatic products including aquatic grasses, plants for human consumption, snails, mussels and other products is Tk 37 million (11% of total value). The value of dry season pastureland in the Haor is also very significant at Tk 44 million (12% of Haor value). The value of the Haor for recreation and flood control are also Tk 7 million and Tk 23 million. The biodiversity value (Tk 43 million) represents the value of MACH project and likely foreign development assistance to be provided to Bangladesh due to the Haor wetland. It should be noted that the current value of boro rice produced within the Haor is also included (Tk 63 million or 18% of total value).

Table 3.1: Value of annual Hail Haor economic outputs.

Economic Output	Current Total Returns (Tk)	Current Returns (TK /HA)*	Percent	Estimation Approach
1. Fisheries	121,416,707	9,871	34.9%	Ongoing sample monitoring
2. Non fish products	37,666,526	3,062	10.8%	Sample HH survey
3. Recreation	7,025,634	571	2.0%	Hotel and Tourist Surveys
4. Flood Control	23,443,167	1,906	6.7%	Cost Avoided based WB Scheme
5. Tea estate vegetation use	1,916,761	156	0.6%	RRA Survey
6. Project / Biodiversity Funds	43,650,600	3,549	12.5%	Key Informants
7. Transportation	8,758,318	712	2.5%	RRA Survey
8. Pasture value	40,292,840	3,276	11.6%	GIS Extrapolation
9. Boro rice value	63,856,293	5,192	18.3%	GIS Extrapolation
Water quality	Not Done	Not Done	NA	
Aquifer charge	Not Done	Not Done	NA	
Existence values	Not Done	Not Done	NA	
Total (Tk)	348,026,846	28,295	NA	
Total USD	$6,105,734	$496	NA	

* For this calculation total value (Tk) was divided by the 1999 maximum Haor size (12,300 Ha).

Table 3.2 presents returns to specific category groupings of economic outputs. It is significant to note that both overall value per Ha Tk 28,295 (**Table 3.1**) and returns to wetland natural outputs Tk 23,103 exceeds the value of Boro rice production Tk 18,254 per Ha (BBS 1999). This strongly shows that maintaining and improving management of wetland

[9] NPV was calculated for the 15-year period based on a real inflation adjusted interest rate of 5%. See Chapter 2.0 for a discussion of NPV.

resources offers higher economic benefits than conversion of wetlands to Boro rice production.

Table 3.2: Hail Haor economic value by output groupings.

Groupings	Current Total Returns (Taka)	Current Returns (TK /HA)*	Comments
(1) Returns to wetlands	284,170,554	23,103	Returns without Boro rice
(2) Returns to wetlands (no Biodiv)	240,519,954	19,554	Returns without Project Funds and Boro
(3) Returns with no BioDiv Funds	304,376,246	24,746	Returns without Project Funds

3.1 Fisheries

Table 3.3: Summary of annual fish yield and value.

Area	Value	KG
River	3,288,945	54,302
Flood Plain	37,928,636	610,377
Beel	51,856,668	832,783
Canal	28,342,459	469,024
Total	**121,416,707**	**1,966,485**

Note: Yield (ton/Ha): 160

3.2 Non Fisheries Harvested Products

Table 3.4: Non-fish aquatic products annual value.

Product	Quantity (Kg)*	HH Value (Tk)	Total Hoar Value (Tk)**
Shaluk	7.00	68.38	1,712,862
Grass	802.50	821.88	20,588,790
Pokol	28.84	285.16	7,143,449
Snails	15.81	25.06	627,841
Dolkolmi/Khulum	98.13	196.25	4,916,259
Halanchashak	0.03	0.19	4,697
Dunuman Kanpata	0.03	0.19	4,697
Kolmishak	3.20	13.78	345,234
Shapla	6.41	20.97	525,288
Lota	1.13	2.25	56,365
Ugolgrass	65.63	65.63	1,643,972
Gangra	0.69	3.63	90,810
Dona	0.13	0.25	6,263
Total Value	**NA**	**1,503.59**	**37,666,526**

3.3 Recreation

Table 3.5: Annual value of tourist activities.

Tourist Type*	Sample Number	Total Pop*	No. Days	Hotel Cost (Tk)	Transport Cost (Tk)	Willingness to pay (Tk)	Incidentals (Tk)	Value of Time** (Tk)	Total Value (Tk)	Share of Value to Haor ***	Haor Value (Tk)
International*	373	1,119	2	419,625	1,342,800	279,750	1,119,000	6,266,400	3,161,175	50%	1,580,588
Local High	664	2,655	2.25	597,393	1,593,048	398,262	796,524	1,327,540	4,712,766	50%	2,356,383
Local Ave	1,489	5,957	2.25	518,252	2,382,768	595,692	1,191,384	1,489,230	6,177,326	50%	3,088,663
Total	2,526	10,104		1,535,270	5,318,616	1,273,704	3,106,908	9,083,170	14,051,268		7,025,634

* Sample expansion for foreign tourists and domestic tourist differs based on sample characteristics.
** Calculated based on assumed income levels. Note International tourist value not included.
*** Half the tourist value was allocated to the Haor and half to the surrounding area. Tourists primarily visit the tea estates and forest but the Haor is integral to the experience.

3.4 Flood Control

Table 3.6: Annual cost of avoided flood control cost.

Item	Total Cost	Life (Years)	Interest Rate	Annual Cost (Tk)
Capital Cost	140,087,000	15	0.12	20,568,167
Operating Cost	NA	NA	NA	2875000
Total				**23,443,167**

3.5 Tea Estate Vegetation

Table 3.7: Annual economic value of tea garden use of water hyacinth.

Garden/Item	Value
Finley (Tk/Ha)	12
Saif (Tk/Ha)	216
Mirzapur (Tk/Ha)	51
Average (Tk/ha)	93
Total Tea Area (Ha)	**20,633**
Total Value (Taka)	**1,916,761**

3.6 Biodiversity

Table 3.8: Biodiversity project values.

Source	Value USD	Probability	Value Taka
MACH	2,220,000	100%	126,540,000
MACH Construct	6,000,000	50%	171,000,000
Trop Forrest	1,000,000	50%	28,500,000

Exchange Rate (USD=Tk): 57

Table 3.9: Annualized project value.

Source	Project Value (Tk)	Proportion Allocated due to Hail Haor	Value to Hail Haor	Interest Rate	Annual
MACH	126,540,000	1	126,540,000	0.14	17,715,600
MACH Construct	171,000,000	1	171,000,000	0.14	23,940,000
Forest Purchase	28,500,000	0.5	14,250,000	0.14	1,995,000
Total Value	326,040,000				43,650,600

3.7 Transport

Table 3.10: Annual value of boats used for transportation.

No. Boats	New Value	Life	Rate	Boat Annual Value*	Total Value
350	8000	4	0.1	2,524	883,318

* Amortized using Excel PMT function (see text box, Chapter 2.0)

Table 3.11: Annual revenue from boat operations.

No. Boats	Ave No. Workers	Ave Return Worker	Days Worked	Total Value
350	3	50	150	7,875,000

Table 3.12: Total annual value from transport and boat operations.

Item	Value (Tk)
Annualized Boat Value	883,318
Economic Activity	7,875,000
Total	8,758,318

3.8 Pasture and Boro Rice

Table 3.13: Value of boro rice and pasture in Haor wetland area.

Month	Total Area (Ha)	Max Area (Ha)	Land Area (Ha)	Boro Rice (Ha)	Pasture/fallow (Ha)	Pasture Value (Tk)	Boro Rice Value (Tk)
January	4,800	12,300	7,500	3,500	4,000	4,832,000	NA
February	4,000	12,300	8,300	3,500	4,800	5,798,400	NA
March	3,345	12,300	8,955	3,500	5,455	6,589,640	NA
April	3,800	12,300	8,500	3,500	5,000	6,040,000	NA
May	8,800	12,300	3,500	3,500	-	-	NA
June	12,300	12,300	-	-	-	-	NA
July	12,000	12,300	300	-	300	362,400	NA
August	11,850	12,300	450	-	450	543,600	NA
September	11,650	12,300	650	-	650	785,200	NA
October	10,300	12,300	2,000	-	2,000	2,416,000	NA
November	8,300	12,300	4,000	-	4,000	4,832,000	NA
December	5,600	12,300	6,700		6,700	8,093,600	NA
Max Area	12,300	12,300		3,500		40,292,840	63,857,500

Revenue Boro Rice (Tk/Ha): 18,245 (Source BBS)
Revenue Pasture (Tk/Month/Ha): 1,208 (Source BLRI 1999)

3.9 MACH Project Investment Return

The economic returns to the MACH project were also estimated utilizing the bioeconomic model. **Table 3.14** presents the key parameters and results of this analysis. Based on conservative estimates of productivity improvements the **B/C ratio is 4.1 and the IRR is 41%** for the MACH Hail Haor investment. An IRR of 41% for a project tasked with developing approaches to improved wetland management is highly significant.

Table 3:14 Returns to MACH Hail Haor investment.

Parameters:	Annual Project Caused Increase %*	Annual Project Caused Loss Avoided %*
Fisheries	2%	3%
Non fish products	2%	3%
Recreation	5%	0
Results		
B/C	4.1	
IRR	41%	

Note: Time horizon 15 years, MACH investment 2.2 million (USD), and one delay in establishing benefits.

4.0 Recommendations for Policy and Research

4.1 Policy Recommendations

Based on this conservative estimate of Hail Haor wetland value a number of recommendations are indicated. Policy recommendations stemming from the study include:

4.1.1 Wetland Preservation

Broadly wetlands should be preserved because of their higher productivity than alternative agricultural uses. This is indicated by the higher per Ha productivity for the Hail Haor wetland than for alterative Boro rice production. It should be noted that this recommendation is for broad preservation of the Hail Haor wetland. The model is not sufficiently detailed to make micro recommendations concerning marginal conversion of wetlands to boro rice production and vice versa.

4.1.2 Investment in Wetland Productivity

Development resources to improve wetland productivity should be invested. Returns to very modest increases in wetland productivity are demonstrated to have larger economic impacts. Economic benefits from wetlands also benefit disproportionably poorer segments of society.

4.1.3 Watershed preservation

Consequent to the above recommendations it is crucial that watersheds surrounding wetland areas be sustainably managed to control erosion and other negative impacts. Sustainable management of watersheds will have inherent economic benefits and result in preservation of wetland productivity.

4.1.4 Social Mobilization and Institutions

The study results show that wetland economic benefits accrue from diverse sources (nine benefits were quantified). Some of these benefits are also not even fully recognized by recipients (e.g. flood control, water charge, development assistance). To preserve and increase the productivity of wetland outputs social mobilization and institutions are required to organize beneficiary's to press for preservation of resources, investment to improve productivity and to organize sustainable management practices to limit over exploitation of resources.

4.1.5 Recreational Use

It should be stressed that survey research to estimate the value of recreation indicated substantial returns to local tourism and scope to increase recreational use of the Haor. Currently there are no programs or organized activities to attract tourists to the area aside from limited programs at Tea Estates.

4.2 Research Recommendations

Recommendations for extension of the bioeconomic model and research to support sustainable development of wetland resources in Bangladesh include.

4.2.1 Extend Research Base

The methods and bioeconomic model should be utilized to estimate the value of wetland economic outputs by MACH for project sites. MACH should also seek collaboration with related fisheries and natural resource management projects to conduct such estimation. Establishment of a broader base of results will build the case for policies to preserve and enhance the productivity of wetlands. Estimation of economic value for wetlands in different states of degradation will also yield insights into wetland health and productivity. The models can also be updated for specific wetlands across a number of years to develop a time series that can indicate productivity variation and trend.

4.2.2 Estimate Additional Benefits

Methodologies should be developed to estimate the economic value of outputs not quantified in this study. Those approaches should be incorporated in the bioeconomic model. It is particularly important to estimate the impact of the Haor on aquifer charge. This is a potentially large economic value since significant agricultural production and drinking water in the area depend on ground water.

4.2.3 Modeling Project Interventions

To more accurately estimate the returns to specific project interventions and justify those interventions estimates should be made for the impact of specific interventions such as fish sanctuaries, reconnection of water bodies, reducing harvest level of effort on wetland productivity.

4.2.4 Integrated Watershed Bioeconomic Model

The health of wetlands depends on the health of their surrounding watersheds. For Hail Haor there are clear indications that mismanagement of land resources in the watershed is resulting in excessive erosion that threatens to seriously degrade the wetland. To estimate and justify efforts to establish sustainable management in the surrounding watershed a bioeconomic model of a similar type should be developed and integrated with wetland model.

4.2.5 Watershed Erosion Modeling

To develop the integrated model and to determine the potential destructive impact of soil erosion on the health of the Hail Haor wetland it is crucial to model surrounding watershed erosion. This modeling effort should include determining the relative causes of erosion (e.g. poor agricultural practices, deforestation, other) and the effect of excessive erosion on Hail Haor water depth of erosion over time.

4.2.6 Additional Analysis

In the course of conducting this study and associated surveys additional data was collected on a variety of topics. Specific topics for which analysis of collected should be conducted include: (1) Analysis of tourism patterns and potential in Hail Haor, (2) Detailed analysis of the products and user types of non aquatic vegetation, (3) Examination of resource productivity by state of local beels/habitat.

Annexes
Annex A. Assignment TOR

Scope of Work for Luke A. Colavito
Assignment to
Evaluate the Economic Value of MACH Project Area Wetlands

Study Objective
The objective of the assignment is to determine a lower limit on the economic value of wetlands (by quality level) in the MACH project areas and by extension to similar areas in Bangladesh. Establishment of the economic value of wetlands is crucial to justify their preservation and to justify the allocation of resources for their management. In order to justify preservation and management of wetlands it is crucial to demonstrate that the economic value of wetlands exceeds their use as converted agricultural land or poorly managed marginal overexploited areas.

A key assignment deliverable will be the development of a computer application based bioeconomic model that will be a tool for researchers and practitioners to refine and extend the assignment economic analysis. The goal will be to provide a baseline and framework to analyze the economic value of wetlands and improved wetland management.

Study Methodology
The approach to evaluating wetlands economic value in the MACH project sites will be to develop a bioeconomic model of the linkages between wetland size (and quality) with economic outputs of the wetland and its surrounding area of impact. The model will be developed as a computer application.[10]

The model would include a classification scheme of benefits and the annual financial value of those benefits. The stream of annual benefits would then be used to calculate the EIRR (Economic Internal Rate of Return) from wetland preservation and management.[11]

Economic benefits will be estimated under the following standard classification scheme of wetland benefits:

Private Values[12] - These are economic values of products generated from the wetlands (direct benefits) and their surrounding area of impact (indirect benefits) including:
- Fisheries
- Agriculture
- Forestry
- Other

Public Values – These represent public goods generated from the wetlands and include:
- Flood control
- Water quality

[10] The bioeconomic model will be developed either as an Excel based application (automated with VBA) or a MathCAD workbook application. Both applications are available and user friendly.
[11] Note this EIRR would be based on "deducting" the economic value of the next best use for the wetlands.
[12] Note these private benefits are extracted from a common resource and subject to incentives for overexploitation (e.g. the tragedy of the commons) unless management mechanisms are developed.

- Endangered species preservation
- Other

Basic model parameters will include areas of land types within the wetlands and land types in the areas of economic impact by the wetlands. This data set will be developed using project data including project GIS system generated data.

Standard methodologies to estimate each type of benefit will be used. Private benefit coefficients will be estimated utilizing surveys of wetland product users, econometric estimation (if feasible) and published parameters of wetland productivity.

Standard approaches to mixed and public benefits will be evaluated to determine appropriateness to circumstances in Bangladesh.[13] These approaches may include contingent valuation methods, estimation of flood infrastructure mitigated by the wetlands, estimation of flood damage mitigated by the wetlands and the impacts of improved water quality on resource productivity and other aspects.

Consultant Schedule/Deliverables

The assignment will be conducted in three parts (1) a design phase to detail the benefits to be modeled and to design data collection approaches (2) the development of the bioeconomic model software (3) the final phase integrating data into the model and producing the report on economic valuation.

[13] A key issue is whether it is appropriate to use evaluation methods (such as contingent valuation) to estimate existence values and endangered specious values of non-area residents given the level of poverty in Bangladesh and the project area.

Deliverables

Task(s)	Deliverables
• Review documents design details of study approach • Design data collection approaches	• Detailed Methodology submitted for approval • Data collection plan and instruments developed
• Develop bioeconomic model	• Basic software for model developed • Estimate and integrate coefficients from available data
• Finalize assignment	• Seminar and submission of draft report • Submission of final report and model • Training in use of bioeconomic model

Note: The consultant will be engaged for a total of 5 weeks.[14]

Management and Support for the Consultant

The consultant will report to the MACH project Chief of Party. The COP will provide needed support to complete the study objectives. This support will include the designation (either project staff or a consultant) of a local wetlands/fisheries expert for 2 weeks to assist the consultant in data collection. The MACH project will also arrange logistics for collecting information though project or partner staff. Note as a contribution to MACH project match requirements the consultant's wife (Bimala R. Colavito) will assist the consultant and project in the processing of data for the assignment as a volunteer.

[14] Note as per USAID norm consultant would be engaged for a 6-day workweek.

Annex B. Selected Bioeconomic Model Spreadsheets

A. Bioeconomic Model Parameters

(Tables A1 to A4)

Table A1: Global Variables.

Item	Value
Exchange Rate USD=TK	57
Interest Rate*:	0.05

* The real interest rate is exclusive of inflation.

Table A2: Hail Haor water area by month.

Month	River Gopla (ha)	Flood Plain (ha)	Beel and Hoar Area (ha)	Canal Area (ha)	Total Area (ha)
January	150	1445	3025	180	4800
February	150	655	3025	170	4000
March	150	0	3025	170	3345
April	150	455	3025	170	3800
May	150	5425	3025	200	8800
June	150	8905	3025	220	12300
July	150	8605	3025	220	12000
August	150	8465	3025	210	11850
September	150	8265	3025	210	11650
October	150	6925	3025	200	10300
November	150	4935	3025	190	8300
December	150	2245	3025	180	5600
Max Area		8905	3025	220	12300

Source: BCAS GIS analysis.

Table C2: Estimation of hail haor annual fish production.

Month	River Gopla (ha)	(1) Snake-heads	(2) Eel	(3) Major carp	(4) Large catfish	(5) Minor carp	(6) Prawns	(7) Small Catfish	(8) Small Fish	(9) Knife fish	(10) Exotic species	Total
April	150	1,204.5	0.0	0.0	0.0	0.0	0.0	975.0	162.0	0.0	0.0	2,342
May	150	13.5	63.0	0.0	0.0	0.0	640.5	12.0	681.0	0.0	0.0	1,410
June	150	297.0	490.5	0.0	16.5	3.0	319.5	397.5	3,652.5	0.0	0.0	5,177
July	150	210.0	439.5	0.0	28.5	0.0	18.0	667.5	4,777.5	3.0	0.0	6,144
August	150	289.5	58.5	0.0	27.0	0.0	256.5	405.0	3,700.5	19.5	0.0	4,757
September	150	22.5	0.0	30.0	0.0	0.0	0.0	219.0	3,444.0	10.5	0.0	3,726
October	150	358.5	102.0	0.0	0.0	0.0	1.5	103.5	3,105.0	0.0	0.0	3,671
November	150	189.0	1,018.5	33.0	0.0	0.0	7.5	1,114.5	3,792.0	13.5	0.0	6,168
December	150	88.5	363.0	39.0	549.0	132.0	64.5	885.0	10,015.5	0.0	0.0	12,137
January	150	130.5	0.0	0.0	0.0	0.0	0.0	72.0	364.5	0.0	0.0	567
February	150	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
March	150	865.5	1,539.0	0.0	0.0	0.0	295.5	859.5	4,470.0	0.0	175.5	8,205
Total Kg		3,669	4,074	102	621	135	1,604	5,711	38,165	47	176	54,302
Prices		60	65	85	100	70	50	60	60	50	50	NA
Total Value		**220,140**	**264,810**	**8,670**	**62,100**	**9,450**	**80,175**	**342,630**	**2,289,870**	**2,325**	**8,775**	**3,288,945**

Month	Flood Plain (ha)	(1) Snakeheads	(2) Eel	(3) Major carp	(4) Large catfish	(5) Minor carp	(6) Prawns	(7) Small Catfish	(8) Small Fish	(9) Knife fish	(10) Exotic species	Total
April	455	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
May	5,425	3,255.0	813.8	0.0	0.0	0.0	0.0	271.3	379.8	0.0	0.0	4,720
June	8,905	3,473.0	1,246.7	0.0	89.1	0.0	1,246.7	1,602.9	14,871.4	0.0	0.0	22,530
July	8,605	28,912.8	8,260.8	0.0	774.5	0.0	3,442.0	11,014.4	100,248.3	0.0	0.0	152,653
August	8,465	9,396.2	2,370.2	0.0	84.7	169.3	3,640.0	8,549.7	62,387.1	931.2	0.0	87,528
September	8,265	16,860.6	8,430.3	330.6	0.0	0.0	413.3	5,207.0	139,761.2	82.7	0.0	171,086
October	6,925	6,232.5	69.3	69.3	30,331.5	0.0	0.0	969.5	34,694.3	207.8	138.5	72,713
November	4,935	6,267.5	1,579.2	0.0	888.3	0.0	246.8	4,737.6	59,220.0	98.7	0.0	73,038
December	2,245	471.5	44.9	0.0	0.0	22.5	179.6	2,177.7	19,284.6	0.0	0.0	22,181
January	1,445	43.4	0.0	0.0	0.0	0.0	43.4	274.6	3,569.2	0.0	0.0	3,930
February	655	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
March	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Total Kg		74,912	22,815	400	32,168	192	9,212	34,804	434,416	1,320	139	610,377
Prices		60	65	85	100	70	50	60	60	50	50	NA
Total Value		**4,494,735**	**1,482,982**	**33,987**	**3,216,795**	**13,423**	**460,580**	**2,088,267**	**26,064,930**	**66,013**	**6,925**	**37,928,636**

Month	Beel & haor area (ha)	(1) Snake-heads	(2) Eel	(3) Major carp	(4) Large catfish	(5) Minor carp	(6) Prawns	(7) Small Catfish	(8) Small Fish	(9) Knife fish	(10) Exotic species	Total
April	3,025	635.3	181.5	0.0	0.0	0.0	484.0	968.0	2,026.8	0.0	0.0	7,321
May	3,025	151.3	0.0	0.0	0.0	0.0	0.0	332.8	0.0	0.0	0.0	3,509
June	3,025	2,268.8	816.8	0.0	0.0	0.0	6,443.3	907.5	13,431.0	0.0	0.0	26,892
July	3,025	363.0	423.5	0.0	0.0	0.0	847.0	453.8	5,777.8	0.0	0.0	10,890
August	3,025	7,834.8	998.3	181.5	151.3	0.0	0.0	5,475.3	11,101.8	272.3	0.0	29,040
September	3,025	23,504.3	5,656.8	423.5	60.5	514.3	665.5	8,681.8	178,596.0	4,386.3	0.0	225,514
October	3,025	21,991.8	2,026.8	181.5	88,935.0	30.3	151.3	7,774.3	68,365.0	1,089.0	0.0	193,570
November	3,025	16,940.0	6,443.3	1,875.5	12,977.3	0.0	60.5	10,103.5	149,798.0	1,391.5	151.3	202,766
December	3,025	15,578.8	363.0	605.0	0.0	272.3	1,845.3	10,769.0	73,870.5	1,179.8	121.0	107,630
January	3,025	393.3	30.3	0.0	0.0	0.0	60.5	272.3	5,535.8	30.3	0.0	9,347
February	3,025	514.3	30.3	0.0	0.0	0.0	30.3	60.5	1,875.5	0.0	0.0	5,536
March	3,025	302.5	1,300.8	0.0	0.0	0.0	635.3	453.8	5,051.8	0.0	0.0	10,769
Total Kg		90,478	18,271	3,267	102,124	817	11,223	46,252	515,430	8,349	272	832,783
Prices		60	65	85	100	70	50	60	60	50	50	NA
Total Value		**5,428,665**	**1,187,615**	**277,695**	**10,212,400**	**57,173**	**561,138**	**2,775,135**	**30,925,785**	**417,450**	**13,613**	**51,856,668**
Month	Canal area (ha)	(1) Snake-heads	(2) Eel	(3) Major carp	(4) Large catfish	(5) Minor carp	(6) Prawns	(7) Small Catfish	(8) Small Fish	(9) Knife fish	(10) Exotic species	Total
April	170	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	170
May	200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	200
June	220	0.0	0.0	0.0	0.0	0.0	0.0	55.0	1,581.8	0.0	0.0	1,857
July	220	3,812.6	1,388.2	0.0	0.0	0.0	2,103.2	1,790.8	12,579.6	0.0	0.0	21,894
August	210	0.0	0.0	0.0	0.0	0.0	1,617.0	6,505.8	25,987.5	0.0	0.0	34,320
September	210	16,842.0	2,998.8	0.0	0.0	0.0	0.0	7,839.3	77,477.4	195.3	0.0	105,563
October	200	16,194.0	3,734.0	0.0	0.0	0.0	0.0	9,460.0	9,094.0	0.0	0.0	38,682
November	190	6,427.7	414.2	45.6	0.0	0.0	0.0	5,323.8	51,472.9	0.0	0.0	63,874
December	180	16,266.6	491.4	599.4	6,298.2	0.0	304.2	23,916.6	53,141.4	210.6	0.0	101,408
January	180	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	180
February	170	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	170
March	170	15,310.2	15,466.6	0.0	0.0	0.0	596.7	12,240.0	56,921.1	0.0	0.0	100,705
Total Kg		74,853	24,493	645	6,298	0	4,621	67,131	288,256	406	0	469,024
Price		60	65	85	100	70	50	60	60	50	50	NA
Total Value		**4,491,186**	**1,592,058**	**54,825**	**629,820**	**0**	**231,055**	**4,027,878**	**17,295,342**	**20,295**	**0**	**28,342,459**

See report for full methodology, monthly yield by species and water type was multiplied by water type area to estimate yield. Yield is conservative because shore fish collection is only partially accounted.

Annex C. Hotel Survey

Hotel Manager/Owner Survey

1. Interviewer:_____
2. Date: _____
3. Hotel Name_____
4. Hotel/Guest House Type_____
5. Respondent Position_____ (Owner, manager, staff, other specify)
6. Tourist/recreational* user numbers by month

Month	No. Foreign Tourist Groups*	No. Domestic Tourist Groups
January		
February		
March		
April		
May		
June		
July		
August		
November		
December		

* Defined as anyone visiting the region for tourism, holiday, or recreational use. Would not include business trips or sole family visits (where no use of natural areas is made)
* Group is a set of people traveling together, maybe a family

7. Average group size of foreign tourist groups?_____

8. Average no of days of foreign tourist group stay?_____

9. Foreign Tourist Nationality by percentage?
USA ( ), Britain ( ), German ( ), Indian ( ), Japan ( ), Other_____ ( ) Other_____ ( ), Other_____ ( ), Other_____ ( ), Other_____ ( )

10. Average group size domestic?_____

11. Average no of days of domestic group stay?_____

12. Home area of domestic tourists by percentage?
Dhaka ( ), Chitagong ( ), Other_____ ( ) Other_____ ( ) Other_____ ( )

13. Average room cost for foreigners?

Room type	Cost (Tk/day)	Percent of Guests
Luxury with AC		
Standard		
Economy		
Other		

14. Average Room Cost Domestic?

Room type	Cost (Tk/day)	Percent of Guests
Luxury with AC		
Standard		
Economy		
Other		

15. Average Meal Cost

Type	Breakfast	Lunch	Dinner	Snack	Total
Foreigner					
Domestic					

16 Average estimate of guest income

Foreigner (professional or not) $/Month (may not be possible): _____

Domestic (Tk. Month):_____

17. Activities of foreign tourists

Activity	**Importance (1 very important 5 not important)**
Fishing	
Waterfowl Hunting	
Upland hunting	
Sightseeing/pleasure driving	
Visiting Tea plantation	
Visiting Haor	
Picnicking	
Bicycling	
Boating	
Canoeing	
Hiking, walking/jogging	
Wildlife Observation	
Photography (nature)	
Other (Please List)	

18. Activities of Domestic tourists

Activity	**Importance (1 very important 5 not important)**
Fishing	
Waterfowl Hunting	
Upland hunting	
Sightseeing/pleasure driving	
Visiting Tea plantation	
Visiting Haor	
Picnicking	
Bicycling	
Boating	
Canoeing	
Hiking, walking/jogging	
Wildlife Observation	
Photography (nature)	
Other (Please List)	

19. Has there been a decline or increase in foreign tourism in the last 5 years (%):_____

20. Has there been a decline or increase in foreign tourism in the last 5 years (%):_____

21. Suggestions for increasing area tourism_____

Annex D. Tourist Survey
Recreational User Survey (Final-Draft)

1. Interviewer: _____
2. Date: _____
3. Hotel Name: _____
4. Hotel/Tea Estate Guest House_____
5. Name of Respondent_____
6. Are you or other people in your household visiting the Hail Haor for recreational purposes? Yes_____ No _____

If yes, which recreational activities have you or other people in your household participated during this visit? (Please estimate the total number of days of participation for each activity for you and other household members)

Recreational Activities		**Total days of participation during the past 12 months**
Fishing		_____
Waterfowl Hunting		_____
Upland hunting		_____
Sightseeing/pleasure driving		_____
Picnicking		_____
Boating		_____
Watching boat races		_____
Hiking, walking/jogging		_____
Wildlife Observation		_____
Visiting Tea Gardens		_____
Photography (nature)		_____
Other (Please List)	_____	_____
Other (Please List)	_____	_____
Other (Please List)	_____	_____

7. In Bangladesh National Parks, Zoos, botanical gardens, and other public facilities use fees are charged. In the Hail Haor area (including surrounding Forrest and Tea estates), there are project efforts for flood control, water supply and storage, and preservation of fish and wildlife. If Hail Haor were managed primarily for water recreation, fish, and wildlife habitat, what is the maximum amount you would be willing to pay through a daily entry/use fee to support these efforts?

Domestic Tourist

____ 0 (nothing) Go to Question 8
____ 1 to 5 (Tk)
____ 5 to 10 (Tk)
____ 10 to 15 (Tk)
____ 15 to 20 (Tk)

Foreign Tourist

____ 0 (nothing) Go to Question 8
____ 0 to 50 (Tk).
____ 100 to 200 (Tk)
____ 201 to 300 (Tk)
____ 301 to 400 (Tk)

____ More Specify (Tk)

____ 401 to 500 (Tk)
____ 501 to 750 (Tk)
____ More Specify (Tk)

8. If you chose $0 (nothing) in Question 7, which statements best explain your answer (check as many that apply).

I am not familiar with the area	_____
Hail Haor has no value to me	_____
I do not care about Hail Haor	_____
Hail Haor is to far from my home	_____
Hail Haor does not have the recreational facilities I need	_____
There are other recreational sites that I prefer to visit (list)	_____
	_____
	_____
Other Specify reason	_____
Other Specify reason	_____

9. What is the Maximum amount you would be willing to pay through an annual voluntary donation to ensure that recreational activities and fish/wildlife habitat at Hail Haor are available in the future to you or your descendants?

Domestic Tourist

____ 0 (nothing)
____ 1 to 100 (Tk)
____ 100 to 200 (Tk)
____ 201 to 300 (Tk)
____ 301 to 400 (Tk)
____ 400 to 500 (Tk)
____ More Specify (Tk)

Foreign Tourist

____ 0 (nothing)
____ 0 to 50 (Tk).
____ 100 to 200 (Tk)
____ 201 to 300 (Tk)
____ 301 to 400 (Tk)
____ 401 to 500 (Tk)
____ 501 to 750 (Tk)
____ More specify (Tk)

10. What is the Maximum amount you would be willing to pay through an annual voluntary donation to ensure that recreational activities and fish/wildlife habitat at Hail Haor are available for Other PEOPLE, even if you do not intend to visit Hail Haor.

Domestic Tourist

____ 0 (nothing)
____ 1 to 100 (Tk)
____ 100 to 200 (Tk)
____ 201 to 300 (Tk)
____ 301 to 400 (Tk)
____ 400 to 500 (Tk)
____ More Specify (Tk)

Foreign Tourist

____ 0 (nothing)
____ 0 to 50 (Tk).
____ 100 to 200 (Tk)
____ 201 to 300 (Tk)
____ 301 to 400 (Tk)
____ 401 to 500 (Tk)
____ 501 to 750 (Tk)
____ More specify (Tk)

In the next section, we would like to find out some information about our survey respondents:

11. Where do you reside (Specify city and locality)? _____
12. How did you travel to Hail Haor (Train, Bus, rental cal, own car, other)? _____
13. What was your transportation cost (per individual or trip total) _____

14. How long did it take you to reach Hail Haor? _____
15. How frequently do you visit Hail Haor?_____
16. What is your gender _____?
17. What is your age_____?
18. What is your profession (government service, business, private service, village resident, other)?_____
19. How many adults (18 or over) including yourself live in your household? _____
20. How many minors (Less than 18) including yourself live in your household? _____
21. What is the highest level of education completed by anyone living in your household?_____
22. Do you own a house? _____ If so How many rooms?_____
23. Please indicate your income annual income?_____

Eco Tourism Development in Hail Haor

24. What type of recreational activities would you like to see added to the Hail Haor area?
    Activity 1 (Canoeing) Yes ____ No_____
    Activity 2 _____
    Activity 3 _____
    Activity 4 _____
    Activity 5 _____

25. Do you feel existing accommodations are of adequate quality to support tourism in the region?

Yes _____ No_____ If not what improvements are needed? _____

_____

Do you feel existing transport facilities are adequate to reach Hail Haor?
Yes _____ No_____ If not what improvements are needed? _____

_____

26. Do you have any suggestions about the management of Hail Haor?

_____

_____

Approach to Completing Recreational Tourist Survey:

Sampling approach

- Take census of available tourists at hotels and tea garden guesthouses.
- Complete a minimum of 50 interviews, with a target of 30 domestic and 20 foreign tourists
- Re-survey same hotels until the number of interviews in completed

Logistical considerations

- Coordinate time and place of interviews with hotel manager. Have the hotel manager contact guests and conduct interviews in lobby or dinning area.
- Defer to advice and requests of the hotel manager in implementing the survey
- Re-survey hotels during the weekend when new guests arrive, consult hotel manager on the new tourist arrivals

Interview Technique

- Explain clearly to respondent that you are conducting this survey for a project to improve the productivity of the Hail Haor area and to preserve the Hail Haor area for recreation and tourism. Explain that some of he questions are sensitive and that the information will be used only for project planning purposes.
- For the questions on the Fees. Inform the respondents that each fee question should be considered independent of the previous fee questions. Express that we need information on their true willingness to pay and not what they think we would like to hear.
- On the transportation question 13 the answer will either be individual for the train or bus or for their group based on the cost of renting a car.