Economic Value of Bangladesh Wetlands

MACH
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Abstract

Wetlands in Bangladesh, just as in the rest of the world, were for long regarded as worthless wastelands to be converted to productive agriculture or residential/industrial plots. There is increasing recognition and evidence worldwide that wetlands are highly productive resources important not only for biodiversity, but also for directly supporting the livelihoods of local people and indirectly for providing environmental services on which most people depend. This study reviews the valuation methods for different types of benefit and provides the first detailed valuation of a major wetland in Bangladesh. It is based on a "bioeconomic" model which estimates most of the use related values of Hail Haor through a combination of detailed estimates of land use/habitat areas derived from a GIS with estimates of productivity and values of nine different products from a mixture of surveys and secondary sources. It does not estimate some potentially important non-use values such as ground water recharge, pollution extraction and existence values.

The results indicate that the annual value of wetland products in Hail Haor in 2000 was about Tk 37,000 or US$650 per hectare. This compares with a net return from the alternative of single cropped boro paddy land of Tk 18,250 per ha. The main contributors to this value were fish and other non-fish aquatic products (plants, grazing values etc.). Most of these products are collected by and provide income or food for the poor. The annual return from Hail Haor in its condition at that time was estimated to be just under US$ 8 million. Restoration of fish catches alone in Hail Haor has raised this to about US$ 10.9 million a year in 2005-06.

A simplified cost-benefit analysis of the impacts of the MACH project across its three sites was also made. It was assumed that most wetland values were not changed through MACH, and that the directly attributable benefits were from changes in fish catches, the future returns from trees planted through the project, the increments in incomes of poor households that take loans for alternative income generating activities through the Resource User Groups, and a small amount for incremental incomes of pineapple farmers who adopt contour cultivation. All of these gains were estimated based on project data, in the case of fish catches this came from detailed monitoring undertaken throughout the project period. Other direct benefits from project interventions such as health and sanitation, returns from alternative crops demonstrated by MACH, or reduced irrigation costs where excavation has improved surface water availability, were not counted. It was estimated that as a result of MACH an additional Tk 297 million worth of fish are caught each year and that this is likely to sustain. Considering the period 1999-2022 and a 6% discount rate, the present value of benefits was estimated at about US$ 45 million, and after allowing for project costs this gave a net present value of about US$ 35 million, benefit cost ratio of 4.7, and an internal rate of return of 56%.

These studies clearly demonstrate that wetland protection and restoration make good economic sense for Bangladesh. The value of resources and services generated by wetlands even when degraded is more than alternative agricultural uses, so further changes in use or drainage of wetlands should be avoided. Moreover MACH has shown that it is not only possible to enhance and restore the productivity of wetlands, but that this is economically worthwhile, offering a better return than many other public investments. Since MACH was a pilot project that involved learning as it progressed, the unit costs of future wetland management and restoration should be reduced. Public funding is required for this since the many poor wetland users lack the resources or initial incentive to organize or invest in such a dispersed resource without outside help. There is also a need to address watershed land management issues – to generate data on the contribution of different land uses to wetland degradation and to regulate land uses and invest in watershed protection to ensure that wetlands continue to be productive and provide the ecosystem services that Bangladesh depends on.

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1 Wetlands and the Importance of Their Valuation

1.1 International Context

Wetlands in official circles in most countries were for long considered to be wastelands to be reclaimed for agriculture. However, literally, a wetland is land that is seasonally or permanently covered by shallow water, as well as land where the water table is close to or at the surface. The Ramsar Convention on Wetlands of International Importance adopts a broad approach to defining the 'wetlands' which it covers, Article 1.1 defines wetlands 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 metres"

Thus wetlands cover a wide variety of habitat types, including rivers and lakes, floodplains, coastal lagoons, mangroves, peatlands, and even coral reefs. In addition, there are human-made wetlands such as fish and shrimp ponds, farm ponds, irrigated agricultural land, salt pans, reservoirs, gravel pits, sewage farms, and canals.

Putting an economic value on something as abstract as the ecological services of a wetland is a difficult idea for most people. While we are familiar with paying for the rice and fish that are grown and caught in wetlands, many of the multiple uses of wetlands are not visible and there is no direct market for services such as clean water, biodiversity, and flood control. There is, however, a growing recognition that such natural benefits do have real economic value and that these values need to be included in decision-making processes. If this is not done then public decisions on uses and changes in use of wetlands will be ill-informed and may not be economically efficient since the costs of changing or losing wetlands will not have been counted (irrespective of any non-economic reasons for maintaining and protecting wetlands). The total value of wetlands can be considered to comprise not only direct human uses (marketed or otherwise), but also indirect benefits to human activities and livelihoods and the potential future benefits of this type which may not be realized at present, and lastly non-use benefits – the values that people place on wetlands as habitats, reservoirs of diverse wildlife and as part of our heritage and culture (Table 1).

Table 1 Examples of economic wetland benefits.

Use Benefits			Non-Use Benefits
Direct Use Benefits	**Indirect Use Benefits**	**Option Benefits**	**Existence Benefits**

• Commercial and subsistence harvest:
  • fish
  • trees
  • wild food plants
  • crops
  • fuel
  • fodder
 	
• Recreation:
  • boating
  • birding and wildlife viewing
  • walking
  • fishing
	• nutrient retention
	• water filtration
	• flood control
	• shoreline protection
	• groundwater recharge
	• external ecosystem support
	• micro-climate stabilization
	• erosion control
	• associated expenditures, e.g., travel, guides, gear, etc.
		• potential future uses (as per direct and indirect uses)
		• future value of information, e.g., pharmaceuticals, education
			• biodiversity
			• culture
			• heritage
			• bequest value

Modified from Barbier *et al*. (1997)

1.2 Bangladesh Wetlands

The value of wetland uses and services in Bangladesh is vitally important to national policy issues and also provides key international lessons. As a nation Bangladesh has the highest concentration of wetland dependent people in the world.

Bangladesh is traversed by numerous rivers and creeks as it comprises most of the delta of two great rivers – the Ganges and Brahmaputra. About two-thirds of Bangladesh may be classified as wetlands according to the Ramsar Convention definition. About 6-7% of Bangladesh is always under water, and in the monsoon 21% is deeply (>90 cm) flooded and around 35% experiences shallow inundation (FAO, 1988). Wetlands in Bangladesh encompass a wide variety of changing ecosystems including mangrove forests, natural lakes, freshwater marshes, reservoirs, oxbow lakes, haors (deep depressions in the north-east that form a seasonal inland sea), permanent freshwater depressions (beels), fish ponds and tanks, estuarine waters, and extensive seasonally inundated floodplains.

Over half of Bangladesh comprises floodplains. 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. Floodplains provide a critical source of income and nutrition for millions of rural Bangladesh's poorest people – intensive use for agriculture, fishing and collection of other aquatic resources helps to support a population of over 800 people per km^2. Inland fisheries are particularly important: the four million hectares of regularly inundated floodplain wetlands form a major capture fishery (Ali, 1997) and source of livelihoods for rural people, contributing about 46% of all fish consumed (Department of Fisheries, 2000). Over 70% of households in the floodplains catch fish either for income or food (Minkin et al., 1997; Thompson et al., 1999). In fact the Bangali way of life is defined by use of modified wetlands in the traditional saying "Bhate Mache Bangali" (rice and fish make a Bangali). Surveys by MACH have shown that daily per capita fish consumption has increased in the MACH sites from baseline figures in the range 24-49 g/person/day, against recent national decline in fish consumption of 14% during 1995-2000 (Muir 2003). Moreover, natural freshwater fisheries have been in decline in recent years –with wild catches falling by 38% between 1995 and 2002 (Muir 2003), and the impacts on livelihoods and fish consumption have only been mitigated because of a rapid expansion in aquaculture production. Yet these aggregate changes obscure the impact on the poor who lose the ability to catch fish for food and cannot afford to buy so much fish.

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 rapidly growing population.

Since the early 1990s the importance of wetlands in Bangladesh has started to be recognized. There is now a growing recognition in Bangladesh that remaining wetlands are important as demonstrated by changes in policy: the National Water Policy directs that there be no further drainage of wetlands for agriculture, while filling of water bodies for urban and industrial development has become a contentious issue and subject to litigation on environmental grounds. However, there has been little action to reverse the losses and declines in wetland services that have occurred during past decades, with the exception of a few projects notably MACH.

This study seeks to quantify the main values of one major wetland area in Bangladesh – Hail Haor, and highlights the continued significance of non-agricultural uses and services despite the very dense human population and modification of the wetlands. The bio-economic model it is based on forms a basis for assessing changes in value from this degraded state.

1.3 Valuation Issues and Methods

Economic valuation can be defined as an attempt to quantify and value in economic (monetary) terms the goods and services provided by environmental resources or systems, whether or not market prices are available to assist us. When there is no market for a good or service (for example flood control or pollution abatement services), a value has to be found through surrogate methods to establish society's willingness to pay for the good or service. A major problem in assessing the value of ecosystems arises when the services provided, such as climate change regulation or biodiversity conservation, benefit the global community, this type of value has not been considered in the applications and cases presented here since they lie outside the Bangladesh economy. Table 2 summarizes the most common quantitative valuation methods used for wetlands along with some key constraints and limitations.

Table 2 Valuation methods

Method	Applicable to…	Description and Importance	Constraints and limitations
Market Price Method	Direct Use values, e.g. wetland products.	Value is estimated from the price in commercial markets	Market imperfections (subsidies, lack of transparency) and policy distort the market prices for which there are well established correction factor methods.
Damage Cost Avoided	Indirect Use Values: benefits of flood, erosion and pollution mitigation services of wetlands	Loss of wetlands can cause damage or costs to other economic activities. The value of organic pollutant or any other pollutant's removal can be estimated from the cost of building and running a water treatment plant (substitute cost). The value of flood control can be estimated from the potential average damage if flooding would occur with higher frequency/ intensity without a wetland (damage cost avoided).	Estimation of what would happen without or with a degraded wetland may be difficult and uncertain - the method may therefore lead to under- or overestimates.
Replacement Cost or Substitute Cost Method	Total wetland value or partial use values	Alternative sources of services available in the market (e.g. fuel sources) can be valued; at the macro level cost of an "equivalent" replacement wetland	Tend to be partial estimates. It is assumed that the cost of substitutes matches the original benefit. Impossible to create exact equivalent wetlands and time to achieve this not always considered.
Travel Cost Method	Recreation and Tourism	The demand function for recreation at a site is estimated from the amount of money that people spend on reaching the site.	Overestimates are easily made as the site may not be the only reason for traveling to that area. Only applicable to attractive sites. Data intensive.
Hedonic Pricing Method	Some aspects of Indirect Use, Future Use and Non-Use Values	This method is used when wetland values influence the price of property or wages. Large surface of water or aesthetic views can increase the price of houses or land.	This method only captures people's willingness to pay for perceived benefits based on location/residence. If people do not perceive an environmental benefit to themselves, the value will not be reflected in the price. Data intensive and only feasible where house prices are readily available.
Contingent Valuation Method	Tourism and Non-Use values	This method asks people directly how much they would be willing to pay for specific environmental services. It is often the only way to estimate non-use values.	There are various sources of possible bias in the interview techniques. There is also controversy over whether people would actually pay the amounts stated in the interviews. It is the most controversial non-market valuation method but is one of the only ways to assign non-use values where there is no market.
Contingent Choice Method	For all wetland goods and services	Estimate values based on asking people to make tradeoffs among sets of ecosystem or environmental services	Does not directly ask for willingness to pay as this is inferred from tradeoffs that include cost attribute. Can help decision makers to rank policy options.

2 Study Sites

The MACH project is supported by USAID and has been working since late 1998 in three large wetland areas in Bangladesh for their restoration and sustainable management: Hail Haor, Turag-

Bangshi, and Kangsha-Malijee wetlands. The valuation study covered the deeply flooded and largest of the sites – Hail Haor, while the estimation of benefits from MACH project covered a limited range of uses in all three wetlands.

Hail Hoar, located in Moulvibazar District in north-east Bangladesh, is a large basin surrounded by low hills on three sides. The haor receives water flowing out of 59 small streams draining the surrounding hills (a water catchment area of about 600 km^2) and the Lungla-Bilashi River. It becomes a large single body of water of approximately 13,000 ha in the rainy season and is reduced to a series of smaller but still substantial water bodies totaling about 3,000-4,000 ha in the dry season of an average year. The villages surrounding the haor and which are the primary users of the haor were inhabited by about 172,000 people in 1999.

Hail-Haor was formerly connected with the Kushiyara and Manu Rivers. A series of flood control dikes along these rivers and a sluice gate on the Kamerkhali Khal restrict river flows and fish access to and from the haor. Another dike, now in disrepair, was built around the northeastern and eastern sides of the haor, supposedly to reduce the impacts of flashfloods and to turn the haor into a large reservoir. The Shaka Borak River and Kamarkhali Khal pass through Boro Haor (north of Hail-Haor) and, if it were not blocked, would connect the Gopla River (which flows through the haor) with the Kushiyara River.

3 Methods

3.1 Approach

Total economic value is now well established as a framework for defining ecosystem, including wetland, economic benefits (Barbier et al. 1997). This approach was adopted in this study for Hail Haor, but it focused mostly on direct values. Many of even these more readily quantified benefits have tended to be ignored and under appreciated in Bangladesh

The approach taken for the estimation of wetland economic values was to estimate the annual value of various economic outputs from the land covered by the wet season water area. The economic output valued was the gross revenue generated by primary activities associated with the wetland resources. An attempt to estimate value added by activity and alternative activities was not attempted. However, it should be noted that since these wetland 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 wetland value is conservative.

With the exception of the value of wetland land use for agriculture, all of the benefits valued are derived from the use of common pool resources (mainly fisheries) and public goods such as flood mitigation. The studies were conducted at the early stage of introducing improved community based management practices in the two sites, and reflect conditions when the common pool resources were in a degraded condition due to externalities, open access and inappropriate property right regimes, for example extraction of maximum short term fish catches encouraged by the leasing system, over fishing where there was open access, and siltation of wetlands due to poor soil management practices in nearby hills.

Public values refer to positive externalities 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.

3.2 Area Definition

The first issue was to define the wetland area to be valued. In Hail Haor thanks to a detailed monitoring program and GIS, the wetland was defined as the maximum water extent around the time of the valuation (base year for valuation is the Bangla year: April 1999 to March 2000), maximum water extent occurred in June 2000 (12,300 ha). Moreover for use in the spreadsheet based bioeconomic model developed for the study, the water areas by type (permanently inundated river, channel and *beel* (depression), and seasonal floodplain) were estimated for each month. Hence the study covered the whole wetland. Grossing up for fish catches was based on monthly areas inundated as estimated from the GIS model and monthly water level records.

3.3 Types of Values Quantified

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. Table 3 outlines the methods adopted.

Table 3 Summary of potential benefits of wetlands and the valuation estimation approaches used in Hail Haor

Type of benefit	Method/comments
Direct values	
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.
Non fish products	A stratified sample household survey was conducted in villages surrounding Hail Hoar. Results were scaled up based on total population of the surrounding villages.
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 scale up the results.
Pasture	The area of pastureland was estimated by deducting from the non-inundated area in each month the area of boro rice and utilizing the GIS database to determine pasture area. An extremely low value of returns per ha pastureland was then used to scale up.
Boro rice (dry season)	Similar to pasture, area was estimated and a standard value of boro rice production was used.
Aus-Aman rice (monsoon season)	Not grown in floodplain/wetland as defined here
Transportation	An RRA survey was conducted at key boat launching sites.
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
Indirect values	
Flood control	A cost avoidance approach was used. The cost avoided was given by a proposed BWDB flood control scheme proposed for the Haor.
Water quality	Not estimated but will be a significant value as the Haor acts to purify water through natural processes.
Aquifer charge	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
Option values	
Value of maintaining ecosystem and its components for potential future uses	Not estimated, other than through biodiversity value (see below)
Existence values	
Existence values	The intrinsic value of the Haor nationally and internationally was not valued, however unlike many smaller wetlands in Bangladesh it is likely to be significant as the Haor is internationally important for its biodiversity – listed in Asian wetlands directory (Scott 1989). Since the valuation it has been listed as one of only 19 Important Bird areas in Bangladesh (Birdlife International 2004), and has been proposed as a Ramsar site.
Biodiversity	Key informants provided information on the value of MACH and other potential projects to be partially targeted because of experience in Hail Haor. The annual cost of these investments was then used as a surrogate measure.

3.4 Fisheries

In Hail Haor to estimate overall fish yield the MACH GIS database was utilized to estimate by month the area of the four water types. 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: they are not as visible as boat based fishers, and the catch monitoring areas contain proportionally less shoreline than the entire haor. The fact that fish yield estimation is probably 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 fishers to lessees were not included in the estimation. These fees are transfer payments and 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.

3.5 Non Fisheries Harvested Products

People living for several kilometers around Hail Haor are extracting a wide variety of products from the haor and these products have very significant value. 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.

It was reported that three tea estates were extracting vegetation from the haor to use as mulch/manure. Key informants were interviewed to find out the amounts and cost of water hyacinth that they collect.

3.6 Recreation

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

3.7 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 in either of two scenarios. 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, flood control structures would be required to control flooding of water on to the boro rice area and beyond.[1]

The Bangladesh Water Development Board developed and submitted a proposal for World Bank loan funding for a flood control scheme in 1996 for Hail Haor (which fortunately has not been implemented). This proposal aimed to change land use in the haor by draining and protecting boro rice from floods, rather than to protect from flood damage existing land uses around and downstream of the haor that would suffer a higher flood risk without the haor. The costs for this scheme were updated to current prices and annualized by amortizing capital costs to estimate the annual value of Hail Haor flood control. This figure 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

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

3.8 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.

3.9 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.

3.10 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.

3.11 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 the value to Bangladesh society of Hail Haor. Table 4 details the outputs not modeled and the reasons those benefits were not modeled.

Table 4. Hail Haor economic benefits not modeled.

Output	Implication / Reason not modeled
Aquifer discharge	The hoar charges 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. The project did not have the capability to model the hydrologic effect of Hail Haor degradation. The value of this economic output will be large.
Water quality	Natural wetland processes 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. MACH was 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 habitat to a variety of wildlife such a 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 fertilize less land.

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. It is difficult to estimate without a survey, and the existence value of foreigners should not be included in national value estimate.

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. It was expected that something of the former ecosystem and environment along with its productivity and value could be restored through the MACH project.

4 Value of Hail Haor Wetland

The ecosystem approach of MACH and detailed monitoring program gave an opportunity to make a detailed assessment of the economic value of Hail Haor by developing a simple bio-economic model using data from 1999-2000. For this calculation the 1999 maximum haor extent was used (12,300 ha). The annual economic output value estimated for Hail Haor in this study is Tk 454 million (USD 7.98 million). The net present value (NPV) of this benefit stream over 15 years is Tk 4.6 billion (USD 79.7 million).[2] The NPV of one hectare of this wetland is Tk 373,000 (USD 6,568).

Value is presented in both absolute terms and per hectare of the haor. Table 5 indicates that the annual value of non-fish aquatic products including aquatic grasses, plants for human consumption, snails, mussels and other products is as high as that of fish. The value of dry season pastureland in the haor is also very significant at Tk 40 million (9% of haor value). The biodiversity value (Tk 43 million) represented the value of the MACH project and likely foreign development assistance to be provided to Bangladesh due to its experience in protecting the haor. More detailed breakdowns of some of these estimates are given in the Annex.

Table 5 Estimated value of Hail Haor economic outputs in 1999-2000.

Type of good or service	Total returns (Tk)	Value per area (Tk /ha)*	Percent
Commercial fisheries	56,272,200	4,580	12
Subsistence fisheries	83,651,100	6,800	18
Non fish aquatic products**	127,973,300	10,410	28
Boro rice value	63,857,500	5,190	14
Project / biodiversity funds	43,650,600	3,550	10
Pasture value	40,292,800	3,280	9
Flood control	23,443,200	1,910	5
Recreation	7,025,600	570	2
Transportation	8,758,300	710	2
Total (Tk)	**454,924,600**	**37,000**	**100.0**
Total (US$)	**$7,981,100**	**$650**	

Water quality, aquifer recharge benefits and existence value were not valued.
* Total output value divided by maximum water area (12,300 ha in 1999).
** Includes aquatic plants used by local residents and by tea estates.
Exchange rate at that time US$ 1 =Tk 56.9

> **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 6% is used. This represents the inflation adjusted return on investments.
>
> **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.

The estimates are conservative since a number of important benefits and uses from the haor that are difficult to value were not included. Although boro rice is grown in a significant part of the wetland, it is clear that if the rest of the haor to be converted to rice production there would be an economic loss to the nation as well as to the local community, since at that time the net return from Boro rice was only 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. For comparison estimates of the value of Hail Haor with and without the returns from current boro cultivation and the value of projects to restore biodiversity are shown in Table 6.

Table 6 Economic value by output grouping.

Grouping	Hail Haor		Comments
	Current total returns (Taka)	Current returns (Tk /ha)*	
(1) Returns to wetlands	284,170,554	23,103	Returns without Boro rice
(2) Returns to wetlands (no biodiversity funds)	240,519,954	19,554	Returns without Project Funds and Boro
(3) Returns (no biodiversity funds)	304,376,246	24,746	Returns without Project Funds

[2] NPV was calculated for the 15-year period based on a real inflation-adjusted opportunity cost of capital of 6%.

5 Value of Benefits Derived From MACH

With the management improvements put in place through MACH and the co-management systems it has established, significant increases in the value of the wetlands in all three sites could be expected, compared with the value of the Hail Haor wetland at the start of the project as shown above. The interventions adopted through MACH are not expected to affect all of the components of total wetland value, and equally data is only available on some indicators, which by design are linked with the main expected impacts. As the same bioeconomic model is not available for the other two MACH sites, and since only some components of wetland value are believed to have changed due to the MACH intervention, values are only estimated for these changes to assess the economic benefits from MACH. Moreover, other changes, in land uses for example, cannot be directly attributed to MACH.

The main impacts expected from MACH are in terms of changed fish catches. Use of non-fish aquatic resources was also monitored for a sample of households in all three sites but no clear trend emerged, and the RMOs did not set any rules on collection of plants for example. The RMOs did ban hunting of birds in the sites, but this in any case had an insignificant economic value at the start of the project, while benefits from protection are already counted in the biodiversity fund surrogate measure above. Most of the other impacts are generated directly from activities undertaken by local people as a result of support through MACH. For example, the returns from trees planted, from income generating activities supported, and from contour cultivation of pineapple to the farmers. In addition to these activities with marketed outputs there were expected to be benefits from reduced soil erosion and siltation, from eco-tourism, and possibly from improved flows of water and water retention for irrigation. These last impacts could not be assessed as there is no data on any change in sedimentation rates, eco-tourism in any significant numbers only started at Baikka Beel in 2007 and there is limited data, and there is insufficient information on impacts of water flow changes on irrigation to estimate any reduced cost of irrigation. There were in addition various demonstrations of improved agricultural practices, but there is no data to indicate what uptake and net benefits there was from these other than through the returns to FRUG borrowers who were involved.

Therefore only the following impacts that are directly attributable as impacts of MACH have been valued, calculations are shown in Table 7:

1. Changes in annual fish catches (gross value of catch per ha, costs of catching are presumed to have stayed constant)
2. Present value of expected returns from felling trees
3. Increase in household income from activities supported by FRUG loans after allowing for costs and loan repayment
4. Net incremental returns from contour pineapple farmers.

The benefits from MACH are estimated for a period up to 2022, allowing a projection of 15 years from the present. The valuation is made in constant 2006 prices. Since virtually all of the benefits considered here accrue for items that are consumed domestically and which have a high local demand relative to supply or desirable levels of national production, and the benefits mostly go to poorer people, values are based on local market prices. For estimating a present value of benefits a real rate of return (or discount rate) of 6% has been assumed.

Table 7 Valuation of impacts of MACH project, actual benefits to 2006 and projection for 15 years. Valuation at 2006 prices.

Year starting	Fish yield (kg/ha) - blue = average of last 2 years actual data				Fish price (Tk/ kg)	Fish production (t)		Additional value of fish (Tk million) fixed 2006 price (Tk 64.88)	Trees (not swamp)	Pineapple		IGAs						Total benefits (Tk million) at 2006 constant prices
	Turag Bangshi (4,374 ha)	Hail Haor (12,490 ha)	Kansha-Malijhee (8,210 ha)	Overall fish yield (kg/ha) 25,074 ha		Fish production (t)	Incremental production (t)		Harvest 15 years after planting, less replanting costs (Tk million)	Cumulated area planted (acre)	Incremental (net) gain	Income Tk/day after loan repayments	Income Tk/ day constant 2006 prices	Participant income in yr (Tk)	No. of borrowers	Value of loans disbursed (Tk million)	Incremental income per year constant 2006 prices (Tk million)	
1999	57.8	171.1	150.2	144.5	38.81	3,622	0	0	0	0	0	52.4	78.9	19,141	0	0	0	0
2000	124.8	205.1	150.2	173.1	42.32	4,340	717	46.53	0	1.2	0	68.1	96.5	24,838	511	2.33	3.30	49.82
2001	104.8	190.8	150.2	162.5	45.83	4,074	451	29.27	0	5.94	0	66.1	88.4	24,119	2,027	8,27	7.09	36.36
2002	140.1	287.3	149.2	216.4	49.64	5,425	1,803	116.98	0	30.62	0.09	66.4	83.9	24,243	3,728	14.45	6.80	123.88
2003	315.2	161.8	273.4	225.1	53.76	5,644	2,022	131.17	0	71.79	0.39	67.7	80.6	24,692	3,305	10.96	2.08	133.63
2004	320.7	388.6	315.6	352.9	58.22	8,848	5,225	339.03	0	77.44	2.00	69.5	78.1	25,364	3,551	18.52	-1.00	340.03
2005	234.7	256.0	416.1	304.7	63.05	7,640	4,018	260.67	0	92.67	3.85	86.7	91.9	31,642	3,975	22.89	18.92	283.44
2006	277.7	322.3	307.1	309.5	64.88	7,762	4,139	268.55	0	92.67	2.22	89.0	89.0	32,485	3,877	26.21	14.36	285.13
2007	277.7	322.3	361.6	327.4		8,209	4,587	297.58	0	92.67	3.08	88	90	32,063	3,926	24.55	16.61	317.27
2008	277.7	322.3	361.6	327.4		8,209	4,587	297.58	0	92.67	2.32	88	90	32,063	4,001	25.02	16.93	316.83
2009	277.7	322.3	361.6	327.4		8,209	4,587	297.58	0	92.67	2.32	88	90	32,063	4,078	25.50	17.26	317.16
2010	277.7	322.3	361.6	327.4		8,209	4,587	297.58	0	92.67	2.32	88	90	32,063	4,156	25.99	17.59	317.49
2011	277.7	322.3	361.6	327.4		8,209	4,587	297.58	0	92.67	2.32	88	90	32,063	4,236	26.49	17.93	317.82
2012	277.7	322.3	361.6	327.4		8,209	4,587	297.58	0	92.67	2.32	88	90	32,063	4,317	27.00	18.27	318.17
2013	277.7	322.3	361.6	327.4		8,209	4,587	297.58	0	92.67	2.32	88	90	32,063	4,400	27.52	18.62	318.52
2014	277.7	322.3	361.6	327.4		8,209	4,587	297.58	0	92.67	2.32	88	90	32,063	4,485	28.05	18.98	318.88
2015	277.7	322.3	361.6	327.4		8,209	4,587	297.58	13.28	92.67	2.32	88	90	32,063	4,571	28.59	19.35	332.52
2016	277.7	322.3	361.6	327.4		8,209	4,587	297.58	20.75	92.67	2.32	88	90	32,063	4,659	29.13	19.72	340.36
2017	277.7	322.3	361.6	327.4		8,209	4,587	297.58	38.23	92.67	2.32	88	90	32,063	4,748	29.69	20.10	358.22
2018	277.7	322.3	361.6	327.4		8,209	4,587	297.58	60.28	92.67	2.32	88	90	32,063	4,839	30.26	20.48	380.66
2019	277.7	322.3	361.6	327.4		8,209	4,587	297.58	63.43	92.67	2.32	88	90	32,063	4,932	30.85	20.87	384.21
2020	277.7	322.3	361.6	327.4		8,209	4,587	297.58	26.34	92.67	2.32	88	90	32,063	5,027	31.44	21.28	347.52
2021	277.7	322.3	361.6	327.4		8,209	4,587	297.58	4.37	92.67	2.32	88	90	32,063	5,123	32.04	21.68	325.95
2022	277.7	322.3	361.6	327.4		8,209	4,587	297.58	0	92.67	2.32	88	90	32,063	5,222	32.66	22.10	322.00
NPV (6%)								**2,724.35**	**70.74**		**20.86**						**155.87**	**2,971.83**
NPV US$ mill (approx, using only 2006 exchange rate)								**40.06**	**1.04**		**0.31**						**2.29**	**43.70**

In estimating the value of increases in fish catches, the results of monitoring during MACH have been used. This shows the increase in catch per hectare in each site, based on representative areas of the range of wetland habitats found there. Grossing up by the total monsoon water area gives an estimate of total production. To allow for annual fluctuations the average yield of the last two years with survey data has been used to project. This gives a long term average fish yield of 327 kg/ha after MACH compared with 144 kg/ha in the baseline year combining the three wetlands, resulting in an incremental fish production estimated at 4,587 t/year, valued in 2006 prices at Tk 297 million per year. This benefit accrues to those catching fish including leaseholders of parts of Hail Haor that are not under RMOs, the additional benefits to local fish traders and other links in the marketing chain are not considered here. The benefits estimated are conservative because an average fish price based on that faced by local people in the sites is used, but relatively more of the gain in production has come from recovery of higher value species which local people sell rather than consume themselves.

MACH has supported local communities, groups and institutions to plant 644,081 trees of which 236,947 were surviving in late 2006, of these just over 41,000 are to restore swamp forest and will not be felled (although they may be lopped for branches once they are more mature). For the remainder the potential benefits from felling after 15 years have been estimated. It was estimated that each non swamp tree would by then generate 6 cubic feet (cft) of timber and 1.2 cft of fuelwood, the former valued at Tk 200 per cft and the latter at Tk 20 per cft. After deducting a cost of replanting of Tk 60 per tree, this would give a net return to the shareholders in the trees of Tk 1,164 per tree. The total present value of felling the trees in this way would be just over Tk 70 million or US$ 1 million. Under the benefit sharing agreements that cover the different plantations, local poorer people (through committees and RMOs) will receive on average just under a third of the net income, with the rest going mainly to the involved landowners, except that 12.5% of the income from trees on public lands going to the Union Parishads for their development works.

Support for Income Generating Activities through training and micro-credit was provided to poor wetland resource users with the aim of encouraging them to reduce fishing pressure, either by having an additional income source to compensate for observing closed seasons, or in some cases to stop fishing altogether and take up alternative occupations. To be effective these IGAs need to offer a better income than the poor had in the past. Estimates of increased income from IGA loans up to 2006 are based on actual data from project monitoring: the amounts borrowed, numbers of borrowers, and the increment in household daily income reported by a sample of participants. Estimates after 2006 assume that the average participant income of 2005 and 2006 will continue (at constant 2006 prices). The amount of loans (number of borrowers and amount) are expected to grow gradually – the revolving loan funds are expected to grow with the addition of 16% of the interest earned each year. Interest is at 12%, it is assumed based on experience so far that about 80% of the interest is needed to cover FRUG operating costs, and the FRUG constitutions provide for 80% of the net income after those costs to be added to the revolving funds (the remainder goes into an emergency reserve fund). Although the impacts during the project period appear impressive, after inflating previous year's incomes to 2006 prices, the average gain in income per participant household over a year after the project is estimated to be about Tk 4,230 in 2006 prices after allowing for repayment of any loans taken. If the FRUGs use their steadily growing revolving funds in the same way as at present, the incremental income of RUG members is expected to gradually rise from about Tk 16.6 million in 2007 to Tk 22 million in 2022. However, the evidence during MACH project is that RUG member incomes show a substantial increase in the initial years of membership, with modest growth in later years. If the FRUGs implement the policy of graduating members who are raised out of poverty and adding new poor members that is in their constitutions, then the incremental income from the IGA and micro-credit support would be expected to be higher.

In the Hail Haor site monitoring revealed high rates of siltation where streams known as charras flow into the haor. Reviews of land uses in the haor catchment founded that one of the most harmful was pineapple cultivation because it was cultivated in up-down slope rows which results in rapid runoff and high soil erosion in the monsoon. Therefore MACH tested and then successfully extended contour cultivation of pineapple, which was found to increase planting density and leaf cover, reduce soil erosion, and increase farmers' profits. The MACH records show the numbers of farmers adopting contour cultivation and the areas converted to this each year. Based on two demonstration plots compared with a control an estimate of the return over 3 years compared with costs for contour and normal cultivation is available, from this the net gain to the farmer from contour cultivation over normal cultivation was Tk 74,990 per acre. The following conservative assumptions are made: no further expansion of contour cultivation after MACH (although the Department of Agriculture Extension has agreed to continue promoting this practice), the net benefits accrue 3 years after establishing a contour garden (in fact they start earlier), and after the first 3 years the average annual benefit is Tk 25,000 per acre per year. This gives a long term benefit from contour cultivation in this area of Tk 2.3 million per year at 2006 prices.

Overall the driving force in economic impacts from MACH is the estimated gain in fish production from restored wetland ecosystems. On its own this is sufficient to more than justify the project investment. Assuming a 6% real opportunity cost of capital or discount rate, by 2022 the present value of those benefits valued and directly attributable to MACH is predicted to be about Tk 2,970 million or US$ 44 million. Moreover much of the additional products directly benefit the poor, are not traded by Bangladesh and are regarded as having insufficient domestic supply.

6 Benefit Cost Assessment

The total cost of MACH I, MACH II, and ISMP up to June 2007 is the equivalent of about US$ 12.76 million, converting the Taka costs of ISMP to US$ at the prevailing exchange rate in the middle of each year (Table 8). For the purpose of this analysis no further costs were assumed, although it is expected that the equivalent of an additional US$ 1.16 (Tk 80 million) will be spent from the ISMP after June 2007. However, over US$ 0.44 million of this would be spent on outreach and other supports that will benefit other areas not those covered by the main MACH projects (for example, habitat restoration and sanctuaries in other locations and support for alternative incomes for fishers affected by the government ban on catching juvenile hilsha known as "jatka"). In addition the equivalent of US$ 0.2 million has already been spent on similar outreach activities but while these costs have been included in the assessment, no benefits have been estimated. This gives a present value for costs of MACH up to June 2007 of US$ 9.57 million.

Consequently considering the benefits discussed above against the costs to June 2007 (Table 9), using a 6% discount rate and considering the period 1999-2022, the net present value of the MACH program is expected to be just over US$ 35 million, the benefit-cost ratio is 4.7, while the internal rate of return is 56%. This indicates a strong financial and economic return from the investment.

Table 8 Expenditure of MACH projects and benefit- cost analysis

Year	Exchange rate (Tk per US$)	MACH related costs (total, including costs for activities outside MACH areas)					Total benefits		Net benefit (US$)
		MACH-I (US$)	MACH-II (US$)	ISMP (Tk)	ISMP (US$)	Total (US$)	Tk	US$	
1999	48.00	937,790				937,790	0	0	-937,790
2000	50.80	918,361				918,361	49,824,602	980,799	62,439
2001	56.50	1,524,850				1,524,850	36,357,582	643,497	-881,353
2002	57.40	1,627,122		3,232,858	56,322	1,683,444	123,877,216	2,158,140	474,696
2003	57.90	1,158,494	124,908	33,339,899	575,819	1,859,220	133,631,803	2,307,976	448,756
2004	58.00		932,307	56,561,588	975,200	1,907,507	340,027,455	5,862,542	3,955,036
2005	63.00		826,000	64,353,646	1,021,486	1,847,486	283,444,748	4,499,123	2,651,637
2006	68.95		838,523	56,497,015	819,391	1,657,914	285,132,383	4,135,350	2,477,436
2007	68.75		154,736	18,597,915	270,515	425,251	317,274,391	4,614,900	4,189,649
2008						0	316,832,000	4,608,465	4,608,465
2009						0	317,157,131	4,613,195	4,613,195
2010						0	317,488,505	4,618,015	4,618,015
2011						0	317,826,242	4,622,927	4,622,927
2012						0	318,170,463	4,627,934	4,627,934
2013						0	318,521,293	4,633,037	4,633,037
2014						0	318,878,859	4,638,238	4,638,238
2015						0	332,519,498	4,836,647	4,836,647
2016						0	340,361,963	4,950,719	4,950,719
2017						0	358,224,010	5,210,531	5,210,531
2018						0	380,655,281	5,536,804	5,536,804
2019						0	384,206,107	5,588,452	5,588,452
2020						0	347,516,099	5,054,780	5,054,780
2021						0	325,947,424	4,741,053	4,741,053
2022						0	321,997,935	4,683,606	4,683,606
Total		6,166,616	2,876,474	232,582,919	3,718,733	12,761,823	6,585,872,990	98,166,732	85,404,909
PV		**5,136,865**	**2,420,930**	**186,515,223**	**2,996,519**	**9,570,403**	**2,971,826,239**	**44,994,074**	**35,423,671**

PV = Present value at 6% discount rate

7 Conclusions and Recommendations

Based on this conservative estimate of the value of Hail Haor wetland, and the economic analysis of the benefits from the MACH project, several conclusions and recommendations for policy and future research are made. These are of high importance for Bangladesh policy and development programs given that there are at least 60 similar large wetland systems or areas, and that 20-25% of the country comprises wetlands and regularly inundated floodplains upon which a similar proportion of the population depend.

Table 9 Summary of benefit-cost assessment

Benefits		Costs	
Fish catches	25,074 ha	MACH-I	US$ 6.17 mill
	Yield in last 2-3 years 182.9 kg/ha above baseline	MACH-II	US$ 2.88 mill
	Long term additional production: 4,587 t/yr fish	ISMP	Tk 232 mill US$ 3.72 mill
	Tk 297 mill pa benefit	Total	US$ 12.76 mill
	PV US$ 40 mill		
IGAs	Long term increment in income Tk 3,265 household/yr	**Total costs**	US$ 9.57 mill (PV)
	4,000-5,000 borrowers pa	**Total benefits**	US$ 44 mill (PV)
	PV US$ 2.3 mill		
Trees	195,850 survive to felling after 15 years (excluding swamp trees)	**Net present value**	US$ 35.43 mill
	One cycle net return Tk 70.7 mill	**Benefit cost ratio**	**4.7**
	PV US$ 1 mill		
Pineapple	93 ha contour cultivated		
	PV US$ 0.4 mill	**IRR**	**56%**

7.1 Policy recommendations

- **Wetland Preservation.** Wetlands have a higher value to the nation than has previously been recognized so it makes sound economic sense to preserve them. Broadly wetlands should be maintained and preserved because of their productivity and value to the nation as a whole, and to poor local users in particular, which is higher than the alternative agricultural uses. This is indicated by the higher per hectare productivity of Hail Haor than the alterative boro rice production. It should be noted that this recommendation is for broad conservation of wetlands. The model is not sufficiently detailed to make micro recommendations concerning marginal conversion of wetlands to boro rice production and vice versa.

- **Investment.** Development resources should be invested to improve wetland productivity. MACH was a pilot project but has shown that the returns to investment in restoring the productivity of wetlands and helping communities organize to do this are high. Based on the experience gained and approaches developed by MACH the costs of establishing community based co-management, restoring wetland productivity, and enhancing wetland user livelihoods will be lower in future than the costs of learning through a pilot project. For those used to pond aquaculture, the yield per hectare of wild fish from wetlands may appear low, but the areas involved are vast and many of the fish are now of relatively high value. For formerly over-exploited and degraded wetlands the modest increases in wetland productivity achieved by MACH have been demonstrated to have large economic impacts. Economic benefits from wetlands also benefit disproportionately benefit the poor. The large number of wetland users and common pool nature of these wetlands mean that for initial work there are insufficient incentives and social capital for communities themselves to restore wetlands, so public investments are a necessary and sound investment to support community organization and habitat restoration.

- **Watershed Preservation.** To maintain these long term benefits and values it is crucial that watersheds surrounding wetlands are sustainably managed to control erosion, land degradation and any other activities there that could negatively affect downstream wetlands. Sustainable management of watersheds has inherent economic benefits and will 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, ground water recharge, biodiversity). To preserve and increase the productivity of wetland outputs social mobilization is required to organize beneficiaries to press for preservation of resources and to develop institutions to limit over exploitation of resources, and investment to improve productivity.

- **Recreational Use.** With the development of a major wetland sanctuary within Hail Haor and the growing number of people in Bangladesh with sufficient disposable income and interest to make visits to attractive places, the level of recreational use and value of the haor is likely to increase. With growing urbanization and loss of wetlands, recreational demand will likely play an increasing role in the value of wetlands and a pressure for preserving and restoring wetlands in future.

7.2 Program implementation

Improving and restoring wetland productivity depends on a combination of technical management measures and institutional and organizational development.

- **Fish and Wetland Sanctuaries**. These are a key change that drives restoration of fisheries and biodiversity by protecting fish in the dry season so that seasonal wetlands can be repopulated in the monsoon. Proper sanctuary management often involves excavation to deepen dry season habitat and installation of fish protection structures (brush piles or artificial materials such as concrete hexapods) which shelter fish and provide substrata on which fish can forage.

- **Income Generating Activities**. To give fishers incentives to adopt sanctuaries and other fishing restrictions such as closed seasons and an end to dewatering, advice training and access to credit for use in other occupations are an important component of an integrated program.

- **Community Organizations**. The Resource Management Organizations established by MACH were a vital building block in implementing improved management. For sanctuaries and other fishery management rules to be effective they need to be planned by local resource users who have come together to cooperate and have rights to receive the benefits from cooperation and setting limits on their resource exploitation. For this community based organizations that represent the interests of local fishers and wetland users need to be established on a larger scale.

- **Co-management Bodies**. MACH has demonstrated the value of Upazila Fisheries Committees for coordinating management of wetlands between community based organizations, local government (Union Parishads) and local administration and government agencies (Upazila level). These should spread to other areas not only in support of program implementation but for the long term sustainability of participatory wetland management and protection.

7.3 Research and modeling

- **Extend Research Base.** The methods and the bioeconomic model should be utilized to estimate the value of wetland economic outputs for other wetlands. 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.

- **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 wetlands on aquifer recharge. This is a potentially large economic value since agricultural production and drinking water depend on ground water.

- **Develop an 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 has resulted 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 the wetland model. For example, this will require detailed data on erosion and siltation rates. MACH was able to measure siltation in Hail Haor, but more work would be needed in a wider range of wetlands to measure the relative contribution of different land uses and land use management practices to siltation, so that the problem can be addressed at the source to reduce soil erosion.

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Annex

Non-fish aquatic products: annual value in 2000 in Hail Haor

Product	Quantity (Kg)	Household Value (Tk)	Total Hail Haor 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
Ugol grass	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**

Recreation: Annual value of tourist activities in Hail Haor in 2000

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.

Value of boro rice and pasture in Hail Haor wetland area in 2000

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

Return from Boro Rice (Tk/ha): 18,245 (Source BBS)
Return from Pasture (Tk/month/ha): 1,208 (Source BLRI 1999)