Economic Research Group
Extending the Frontiers of Knowledge on Developing Economies

Assessing Macro Impacts of Community-Based Fishery Management (CBFM) in the Inland Open Water Fishery Sector- An Analytical Exercise with Projections

Sabbir Ahmed, Salma Begum and Sajjad Zohir

26 December 2006

Prepared for the WorldFish Center Bangladesh and South Asia Office
House # 22/B, Road # 7, Block – F, Banani, Dhaka – 1213;
email: wolrdfish-bangladesh@cgiar.org

Economic Research Group
Ground Floor, House # 3, Road # 16, Gulshan – 1, Dhaka – 1212, Bangladesh
Phone # 880-2-8820418, 8816344; url: http://www.ergonline.org; email: info@ergonline.org

ASSESSING MACRO IMPACTS OF COMMUNITY-BASED FISHERY MANAGEMENT (CBFM) IN THE INLAND OPEN WATER FISHERY SECTOR
An Analytical Exercise with Projections

By

Kazi Sabbir Ahmed
Salma Begum
Sajjad Zohir

in association with

Khan Zohirul Islam

26 December 2006

Economic Research Group
House # 3, Road # 16, Gulshan – 1, Dhaka – 1212
http://www.ergonline.org

This document is an output from a project funded by the UK Department of International Development (DFID) for the benefit of the developing countries. The views expressed are not necessarily those of DFID.

The study was prepared for the WorldFish Center, Bangladesh and South Asia Office. Kazi Sabbir Ahmed and Salma Begum are Lecturers at the Department of Economics, North South University, Dhaka. Khan Zohirul Islam is a recent graduate in Economics from the Shahjalal University of Science and Technology. Economic Research Group provided the umbrella for undertaking the research. The research team acknowledges the assistance received from Mashfiqur Rahman Khan, Research Associate, Economic Research Group. The ERG team also expresses gratitude to M.A. Rab, Malcolm Dickson, Muzaffar Ahmed and Nurul Islam of WorldFish Center for their supports and valuable comments at various stages in the study.

TABLE OF CONTENTS

LIST OF TABLES

Executive Summary

The study estimates a reduced form supply function (of inland capture fishery) using CBFM monitoring data; and uses regression estimates and parameter estimates from secondary sources to generate a ten-year (2006-2015) projection of capture fish production. Various alternative scenarios are defined in terms of changes in relative price of fish to non-fish food items, gear usage, size of water bodies as well as scale of operation of CBFM practices. Changes in the contribution of the fishery sector in GDP, and economy-wide impacts in the forms of national output, factor payments and household expenditure as well as changes in poverty situations are also projected under alternative scenarios. The paper summarizes the methods and presents the results of projection and its implications within the broader national context.

The regression estimates suggest that project water bodies of open beel, closed beel and flood plain beels have higher catch of capture fish when compared with control sites of similar types of water bodies. Statistically, these results are more valid (significant) for open and closed beels. Catch of capture fish increases with number of active gears and area of the water bodies. Moreover, output is estimated to be higher for open beels in dry season as compared to rivers. Capture fish production is found to rise with increase in the relative price of capture fish to non-fish food items. However, the latter estimate is found not to be statistically significant.

The estimated (capture fish) supply function enabled projections of total catch of capture fish till 2015 under five alternative scenarios. Scenario 1 visualized continuation of the state of affairs as observed in 2005, which was the base year. In other words, scenario 1 shows what might happen to catch of capture fish if the variables affecting capture fish production continue to remain at their base values, defined either in terms of levels or as annual percentage changes observed in 2005. In particular, this involved no changes in the size of the water bodies as well as in the scale of operation of CBFM-2 type intervention. However, relative price of capture fish to non-fish food items and number of active gears were allowed to increase at their historical rates. Under this situation, it was estimated that catch of capture fish would increase by 62.59 percent during 2005 - 2015.

The second scenario assumes a slower rate of increase in the number of active gears compared to that envisaged under scenario 1. This leads to a lower projected increase in catch of capture fish - only 31.51 percent during 2005 - 2015. Scenario 3 assumes the size of water bodies to decline while CBFM-2 type activities are assumed to be scaled up to more water bodies. In addition, relative price is assumed to remain unchanged together with a slower rate of growth in active gears. Given these assumptions, catch of capture fish is estimated to increase by 39.51 percent in 2015 compared to 2005.

Scenario 4 is similar to scenario 3, except that the relative price is assumed to increase at a rate of 2.5 percent. Under this alternative scenario, the catch of capture fish is projected to increase at a marginally higher pace compared to Scenario 3 - about 40 percent higher

in 2015 than 2005. The results reflect positive but insignificant association between prices and supply, which clearly indicates significant presence of non-price variables in determining supply of capture fish.

Scenario 5 involved reductions in the size of the water bodies as well as more scaled up activities of CBFM (as compared to scenarios 3 or 4). Here, relative price and number of active gears were allowed to increase at rates observed during the base year (as in scenario 1). As a result, total catch of capture fish is projected to increase by 113.63 percent during 2015 - 2005.

Given these estimated changes in fish catch, an attempt is made to estimate the corresponding changes in the shares of capture fish (and fishery sector) in gross domestic product (GDP) under alternative assumptions. For the last one decade, contribution of fish has been hovering around 5% to 6% of GDP and it is often apprehended that the share may decline in future (BBS). However, the projected increase in fish production and the resulting share of fishery in GDP found in this study indicate that a reversal of the declining trend is possible. Under a rather stringent set of assumptions regarding price of fish as a whole and other variables, fish sector's contribution to GDP is estimated to gradually rise from its share of 5% in 2005 to 7.98% in 2015 under the projected increase in scenario 1. In 2015, the share of the fish sector has been estimated to rise to 7.44% under scenario 2, 6.71% under scenario 3, 10.44% in scenario 4 and 8.85% under scenario 5.

The final exercise of the study uses an existing Social Accounting Matrix (SAM) to estimate the economy wide impacts of the estimated increase in output in inland capture fishery (translated into 'other fish' category). Under scenario 1, national output is estimated to increase by 8.9%; factor payments to land, labor and capital to rise by 8.86%; and consumption of households is estimated to be 8.91% higher in 2015 compared to 2005. The increase in national output is estimated to be 4.48% under Scenario 2, whereas factor payments and household consumption would rise by 4.46% and 4.49% respectively in 2015. The lower margin of increase is due to smaller projected increase in fish catch under scenario 2 than scenario 1. In all cases of national output, factor payments and household consumption under Scenarios 3 and 4, the increases are projected to be around 6%; and the corresponding figure is around 16% under scenario 5 due to the tremendous projected increase in fish production of 113.63%.

The resulting impacts on poverty for various households have been also simulated. National poverty is estimated to decline by 11.57% due to the rise in household expenditure in scenario 1. The lower bound, defined by scenario 2, is a reduction of poverty by only 5.68%. The most optimist reduction of poverty, by 20.6% during 2005-2015, is observed under the fifth scenario. While poverty reduction is observed across all social groups, it is more prominent amongst the medium educated households, marginal farmers, large farmers and the low educated farmers.

Finally, a word of caution! The exercise undertaken was constrained by the data the team had access to. While every effort was given to identify a suitable methodological route to make the best use of these data, acceptability of the results remains contingent upon one’s assessment of the reliability (quality) of monitoring data collected and compiled under the CBFM and CBFM-2 projects.

Assessing Macro Impacts of Community-Based Fishery Management (CBFM) in the Inland Open Water Fishery Sector- An Analytical Exercise with Projections

I. Introduction

The Community Based Fishery Management (CBFM) started operation in 1995 with the objective of testing and assessing alternative models of collaboration and partnerships between government, NGOs and communities to address sustainable use of inland fisheries and to improve benefits for the poor fishermen through their participatory involvement in management. The first phase of CBFM ended in 1999 and is commonly referred to as CBFM 1. The second phase (CBFM 2) began in September 2001 as a continuation of the work of CBFM 1. However, in addition, CBFM 2 also seeks to identify and test mechanisms for linking local CBFM arrangements to better manage larger fisheries systems (scaling up) and to inform and influence fisheries policy stakeholders for pro-poor policy formulation.

The CBFM-2 sought out to develop fisheries and micro management model by focusing on beneficiaries' participation in resource management. The aim was to assess whether overall management of the water bodies improved overtime. The indicators such as degree of dependence on the resource for economic and subsistence activities, assets and investment in fishing, fishing access, catch size and use, fish consumption, compliance with fishing rules are the criteria that had been commonly used as the basis of the evaluation of CBFM-2.

Even though a number of studies had been undertaken by various institutions and agencies to assess the impact of CBFM -2 at micro level, the importance and contribution of CBFM type of intervention at the macro or national level are yet to be analyzed intensely. This study has been designed as an attempt to fill this gap of measuring macro-economic benefits and trade-offs of CBFM approaches as well as the consequences of non-management of fishery resources. The study has three components. The first part of the study involved undertaking statistical comparative analysis between project and control households (or water bodies) on the basis of three monitoring data sets on household consumption, income/expenditure and fish catch at water body level. The second component dealt with comparative analysis of Benchmark (baseline) and Impact survey data. Drawing lessons from these two parts, the final component involved developing a suitable model and undertaking simulated projections to assess the contribution of CBFM within a national context.

As part of the final task of the study, a simple model for the fish market has been developed based on the broad framework of demand and supply structure in a multi-market context. Due to data limitations (discussed later in detail), only the fish supply function at water body level has been estimated. On the basis of the estimated function, a number of simulation exercises have been conducted to assess the impact of CBFM 2 on equilibrium solutions using such shock variables as relative price of fish to non-fish food items, number of active gears per hectare, total and mean area of different types of water bodies, and programme status. The projection exercise was undertaken under different sets of assumptions till 2015.

Summary results from the first two components of the overall study has been discussed in section II followed by an overview of the inland capture fishery in Bangladesh in Section III. The latter also includes a review of recent literature with respect to multi-market modeling approach in fisheries sector. Section IV describes the general structure of the model while Section V deals with the estimation process, simulation design and projection scenarios. Results are discussed in Section VI followed by concluding remarks in Section VII.

II. Summary of Findings on Micro Data

As mentioned earlier, the three sets of monitoring data on consumption, income/expenditure and fish production were analyzed under the first phase of the present study. The second phase involved a comparative analysis of benchmark and impact survey data. Detail statistical analysis of the two themes is presented in Annex A, while summary accounts of the results are presented below.

II.1 Summary of Findings on Monitoring Data

II.1.1 Findings on Household Consumption

The consumption data series was analyzed with respect to household average fish production, total fish consumption and amount of fish kept for future consumption. It has been found that in general fish production and consumption (in kg) of project households is higher than control households for **open beel** water bodies. The differences between the production and consumption levels of the two groups are also statistically significant for most of the seasons. Even though project households have been found to keep higher amounts of fish for future consumption than control groups for this type of water bodies, the difference, however, has not been statistically significant for most of the seasons.

Fish production and consumption has been found to be generally lower for project households compared to control households in **closed beel** water bodies. However, the difference between the production and consumption levels of project and control groups is statistically significant for some quarters only. Project households have been also found to keep lower amounts of fish compared to control households. None of the differences between project and control groups are, however, statistically significant

Since there were no control households available in the sample panel for **flood plain beels** and **rivers,** it was not possible to compare the difference across project and control groups for these types of water bodies with respect to fish production, consumption and amounts kept for future consumption.

II.1.2 Findings on Household Income/Expenditure

The income/expenditure data series was analyzed with respect to household food expenditure, non-food expenditure, expenditure on crop production and total expenditure. Analysis for the **flood plain beel** water bodies reveals that food expenditure, non-food expenditure as well as total expenditure of project households is higher than control households for most of the quarters in the sample. The differences between the two groups have been also found to be statistically significant for most of the seasons. Even though expenditure for crop production in **flood plain beel** water bodies was found to be higher for project households than control households in most of the seasons, none of the differences has been statistically significant.

Food expenditure in **open beel** water bodies has been found to be lower for project households compared to control households for most of the seasons. The difference in total food expenditure between project and control groups is also statistically significant for most of these seasons. Total non-food expenditure has been found to be higher for project households compared to control households for most of the quarters. The difference between project and control groups is, however, statistically significant for some of these seasons only. Even though project households incur higher expenditure for crop production compared to control households, the differences are not statistically significant. Similar results have been found with respect to total expenditure of project households compared to control households.

Similar comparative exercise has not been possible for **rivers** and **closed beel** water bodies due to lack of control households in the panel sample.

II.1.3 Findings on Fish Production

It has been seen that amount of fish caught in the project water bodies is higher than that of control water bodies in all the four types of water bodies and also across all the seasons. As a result, total annual fish production measured in kilograms has been found to be higher for the project water bodies than the control ones for the years 2003, 2004 and 2005.

Analysis of gill-net specific production for **rivers** shows negligible difference between average fish production of project water bodies and control sites, except for the June-November 2005 period when average production is reported to be higher for project than control sites and also the difference is statistically significant. Average fish production of gill net in **flood plain beel** water bodies is higher for project sites than control ones for most of the seasons. However, the difference between the average production of project and control sites is statistically significant for two seasons only. Similar results have been found for average fish production of gill net in **open beel** and **closed beel** water bodies.

II.2 Comparison of Benchmark and Impact Survey

When benchmark and impact survey data were compared, it was seen that total annual income of beneficiaries was significantly lower than that of non-beneficiaries in baseline time period (before CBFM 2 scenario) as well as in impact study (after CBFM 2 scenario). However, percentage increase in annual income was about two times higher for beneficiaries than that of non-beneficiaries. Even though total annual income from agriculture, fishing, trade, profession, remittance, self employment, land and equipment rentals increased significantly for both groups, beneficiaries seemed to earn less than non-beneficiaries with the exception of income from fishing.

Regarding sources of income, the contribution of agricultural related activities in total disposable income was found to have decreased for beneficiaries over time whereas it increased for non-beneficiaries. Proportion of income from fishing related activities increased significantly for both groups, but it was about four times greater for beneficiaries than that of non-beneficiaries when "before" and "after" scenarios were compared. In particular, it significantly increased for the direct fishing sector. Direct fishing was found to be the major source of fishing related income for the beneficiary households in both baseline and impact period. Most of the fishing related income for the non-beneficiaries came from fish and fish related trading in baseline, but direct fishing was the main contributor in their fish-related income in the impact period. The contribution of direct fishing in total fishing income stood at about seventy two percent for beneficiaries and sixty one percent for non-beneficiaries in the impact year. Proportion of fishing income from fish labor, fish and fish related trading, fish fry selling, fish pond/culture and from drying and processing of fish declined for both beneficiaries and non-beneficiaries. Thus, it could be argued that the remarkable increase in total fishing income was mostly due to higher contribution of income from direct fishing rather than other sources.

Total expenditure increased significantly both for beneficiaries and non-beneficiaries compared to the base scenario, but it was found to be higher for the beneficiaries. Both beneficiaries and non-beneficiaries reported lower expenditure on food, clothing, and on travel during the impact period. Beneficiary households reported to have incurred higher expenditure for housing compared to the baseline scenario. At the same time, expenditure on loan repayment, land and festival related activities were found to be higher during the impact period for both groups. Importantly, expenditure on education increased for beneficiaries in the impact year whereas it slightly decreased for the non-beneficiaries.

Percentage of households reporting positive expenditure increased significantly for loan repayment, education and land across beneficiaries and non-beneficiaries. Compared to non-beneficiaries, percentage of households reporting positive borrowing increased significantly for beneficiaries. Proportion of households reporting positive number of dwellings and area of dwellings remain more or less unchanged for both groups. However, the percentage of households with positive responses for number of TVs, radios, bicycles, rickshaws/vans and cattle/buffaloes increased significantly for both groups. A higher proportion of non-beneficiary households responded positively on these expenditures. There were more number of beneficiary households reporting positive number of goat/sheep than non-beneficiaries during the impact period.

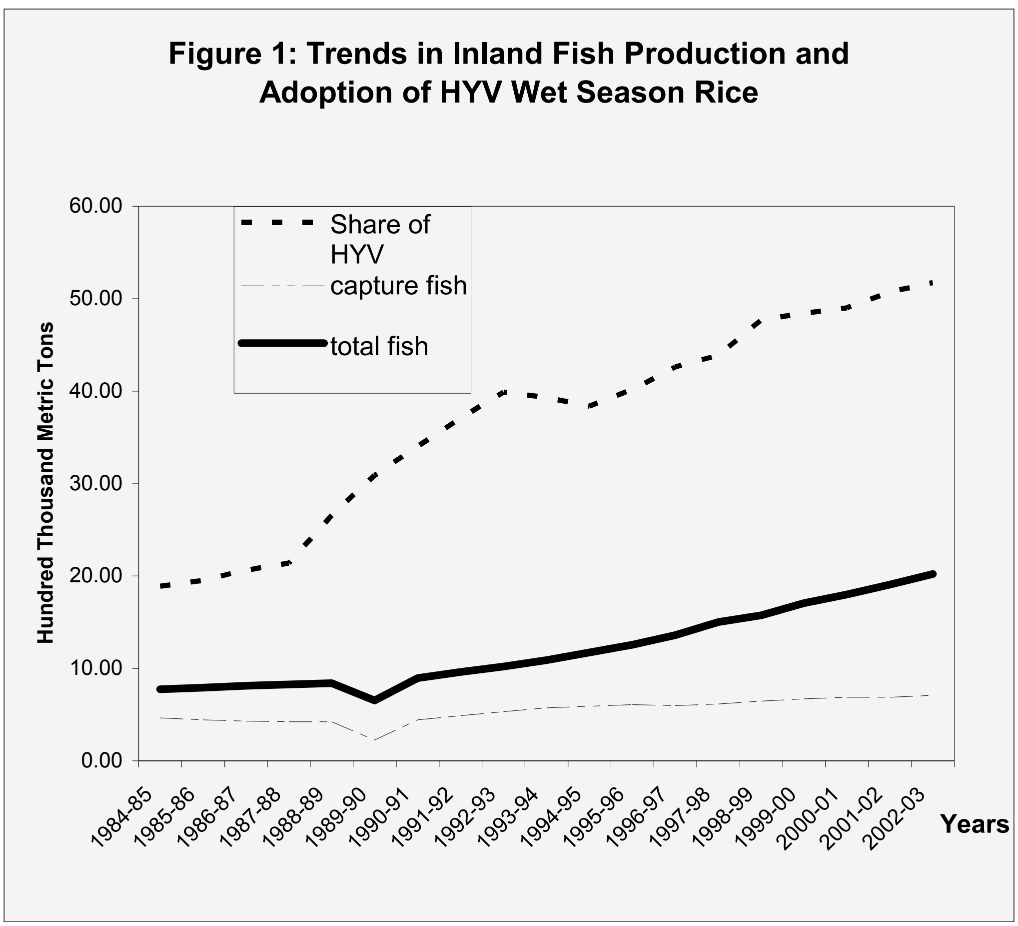
The average area of all kinds of land except khas land was found to be higher for non-beneficiaries both in baseline and in impact periods. Own homestead land, own pond or ditch and land owned but mortgaged out increased for beneficiaries, but these decreased for non-beneficiaries. Land owned and cultivated by the households decreased for both groups. However, own non-cultivated land increased significantly for both groups.

Average years of schooling of children between five and ten years of age marginally changed for both groups. Average years of schooling of children between eleven and fifteen years of age only slightly improved for both groups. Similarly, average years of schooling for adult members (age sixteen or more) increased for both groups.

III. An overview of Inland Capture Fishery in Bangladesh

III.1 Trends in Fish Production

Fishery is an important sector in the economy of Bangladesh. It is the main source of animal protein and a vast majority of people depends on fishing for their livelihood. The fisheries sources of Bangladesh have been broadly divided into inland and marine fisheries. The inland fishery covers an area of about 4.3 million hectare, while the area of marine fisheries is about 7 million hectare. However, inland fisheries remain the most important contributor to fish production in Bangladesh. Within the inland fishery sector, further distinctions are made between capture (open access) and culture (closed water bodies) sources. While the total capture fish production continues to increase, the pace of increase falls far short of the pace of population increase – capture fish production failed to double over the last twenty years (1984/85 to 2004/05, see Annex D#).



Source: Statistical Yearbook of Bangladesh, various editions

It is well known that fish and wet season rice are often competing sectors, particularly when High Yielding Variety (HYV) is adopted with increased use of chemical fertilizer and pesticides. It is therefore no surprise that oncreased adoption of HYV Aman did not permit significant growth in the production of inland capture fish. Figure 1 captures the trends (see also the tables in Annex B), which clearly suggest that the share of inland capture fish in total fish production has persistently declined, especially since the share of HYV in Aman rice took off during the late 1980's.

III.2 Brief Look into the Projection Exercises on Fishery Sector

Given this scenario of inland fishery sector, various studies have been undertaken to model, estimate and project demand and supply of fish in Bangladesh. A number of such studies had been identified from a survey of recent literature. A summary of the approaches taken in some of the most relevant studies is presented below.

In the paper "Disaggregated Projections on Supply, Demand, and Trade for Developing Asia: Preliminary Results from the Asia Fish Model" by Madan Dey (et. al) an attempt has been made to conduct an impact analysis for fish demand, supply and trade. In doing so, the paper relies on the Asia fish model developed by WorldFish Center under a project of the Asian Development Bank (ADB). The Asia Fish Model has consumer, producer and trade cores. Supply equations for fresh fish are derived normalized quadratic profit functions. The demand equations are Almost Ideal Demand System. These demand equations are developed from a three-stage budgeting process. In the first stage consumption expenditure is divided into food and non-food spending. The second stage determines household demand for fish. The final stage captures demand for different types of fish using a quadratic form of Almost Ideal Demand System.

In the trade core, the Asia Fish Model follows the Armington Approach by assuming that domestic and foreign goods are differentiated products. It follows a constant elasticity of transformation for exports and constant elasticity of substitution for imports. The model is solved/closed by attaining simultaneous equilibrium among the demand, supply and trade cores. The model identifies demand and supply composites for matching fish types and then disaggregates the demand and supply composites based on a constant elasticity function.

Projections for production, consumption and trade were made assuming that the exogenous variables followed some assumed changes. The projections were made using 2 scenarios:

- faster technical progress in freshwater aquaculture
- faster technical progress in high value fish in aquaculture

Results from this study indicate that, with rising population and income, fish demand will continue to grow and supply will also rise, with majority of the increase coming from culture fishing. It has been further reported that Bangladesh is likely to experience a long-term decline in per capita fish consumption, unless reversed by aggressive productivity improvements. This result was supported by the projection and simulation of the alternative scenario with higher productivity growth.

In the paper titled "Globalization and Fisheries: Welfare Implications of Export Trade in Asia" by Roenhlano M. Briones (et. al) studies the impact of export-oriented fisheries on the poor fishers, fish farmers and traditional processors. The authors also rely on the Asia

Fish Model and looks at quantitative impact assessment of the effect of rising export price on domestic fish consumption. It expands the framework of the Asia fish model on the supply side by adding different supply functions for capture and culture fisheries. Moreover, processed fish is assumed as a product of fresh fish under fixed proportions technology. In this study, it has been estimated that Bangladesh is expected to have only a slow aggregate consumption growth for fish reaffirming the results from the earlier study. However, this study estimates that consumption would shift away from traditional species such as Indian carps, Pangus, and Hilsha, to newer species such as other carps, high value marine fish and even tilapia.

In the document titled "Fish to 2020: Supply and Demand in Changing Global Markets" by Delgado (et. al.) of International Food Policy Research Institute (IFPRI) attempts to project production, consumption and trade trends of fisheries items on the basis of IFPRI's IMPACT model. The fisheries component of IMPACT includes 4 types of food fish and 2 types of animal feed items made from fish.

Here culture and capture fisheries have not been differentiated for demand purposes. However, the 4 categories of fish have been sub-divided into separate categories of capture and culture on the production side. Supply (culture, capture) and demand (combined) for these six composites interact together to produce six equilibrium prices in each market. For the model balance across production, consumption and net trade for each country has been impost ex-post for the base year (1997).

Projection scenarios include faster aquaculture expansion, lower production in China, fishmeal and oil efficiency increase, slower aquaculture expansion and ecological collapse (extremely pessimistic scenario for capture fisheries). According to the study findings, global food fish production is likely to increase slightly faster that fish population through 2020. The study also reports that investments in culture fisheries targeting low-value fish were likely to help poor fishers benefit from fisheries development.

IV. The Conceptual Framework

It could be envisaged that CBFM 2 type of intervention has the potential to influence outcomes in both fish and non-fish markets as fish production, consumption, household income and various other factors change. Therefore, the conceptual framework has been developed considering two markets in operation: fish and non-fish markets. A set of demand and supply equations would define each of these two markets and simultaneous equilibrium in these markets would lead to solutions based on which projection analysis for future scenario could be conducted.

IV.1 Fish Market

As with any market, demand and supply of fish characterize the fish market. On the supply side, one needs to distinguish between capture and culture according to production source. Moreover, supply of fresh fish needs to be disaggregated by major fish species groups (eg carp, small fish. tilapia, live fish, other freshwater fish etc.). There would be specific supply functions for capture as well as culture fisheries for various species groups. These supply functions would generate the supply of fresh fish of various categories from capture and culture sources which would be ideally a function of relative price, price of inputs, price of competing and substitute goods in production, environmental factors, management options/policies etc.

On the demand side, distinction between capture and culture would also be necessary as these can be assumed to be imperfect substitutes. Considering fish as a heterogeneous commodity, demand functions should also account for species group/fish type. The very broad framework underlying the empirical work involving simulations in this study includes sets of demand and supply equations for the fish market, as described below.

(i) Demand and Supply of Fresh Fish from Capture Sources

$QD_{it}^{cpf} = \alpha_1 + Z_{it1}\beta_1 + u_{it1}$;

where i refers to categories of fish and QD_{it}^{cpf} is household demand for fresh fish (capture) and Z_{it1} is a set of independent variables which includes relative price of capture to culture fish, relative price of fish to non-fish food items, income, and some socio-economic variables such as programme status, types of water bodies, baseline category of fishermen etc.

$QS_{it}^{cpf} = \alpha_2 + Z_{it2}\beta_2 + u_{it2}$;

where i refers to categories of fish and QS_{it}^{cpf} is household supply for fresh fish (capture) and Z_{it2} is a set of independent variables which includes relative price of capture to culture fish, relative price of fish to non-fish food items, cost of fishing, size of the water body, percentage time spent using a particular gear, biological stock/growth of fish stock, and some socio-economic variables such as programme status, types of water bodies, baseline category of fishermen etc.

(ii) Demand and Supply of Fresh Fish from Culture Sources

$$QD_{it}^{clf} = \alpha_3 + Z_{it3}\beta_3 + u_{it3}$$

where *i* refers to categories of fish and QD_{it}^{clf} is household demand for fresh fish (culture) and Z_{it3} is a set of independent variables which includes relative price of capture to culture fish, relative price of fish to non-fish food items, income, and some socio-economic variables such as programme status, types of water bodies, baseline category of fishermen etc.

$$QS_{it}^{clf} = \alpha_4 + Z_{it4}\beta_4 + u_{it4}$$

where *i* refers to categories of fish and QS_{it}^{clf} is household supply for fresh fish (culture) and Z_{it4} is a set of independent variables which includes relative price of capture to culture fish, relative price of fish to non-fish food items, cost of fishing, size of the water body, percentage time spent using a particular gear, stock of fish, land price, and some socio-economic variables such as programme status, types of water bodies, baseline category of fishermen etc.

IV.2 Non-fish Market

Following similar notions of a market, the demand and supply functions for the non-fish market could be developed. Since the focus of the study is obviously on the fish market, the demand and supply functions in the non-fish market would be in aggregate form. These are:

$$QD_{jt}^{nf} = \alpha_5 + Z_{jt5}\beta_5 + u_{jt5} \;;$$

where *j* refers to categories of non-fish product and QD_{jt}^{nf} refers to household demand for the j[th] category of non-fish item at time t and Z_{jt} is a set of independent variables such as relative price of non-fish to fish, general price index, income, and socio-economic variables.

$$QS_{jt}^{nf} = \alpha_6 + Z_{jt6}\beta_6 + u_{jt6}$$

where *j* refers to categories of non-fish product and QS_{jt}^{nf} refers to household supply for the j[th] category of non-fish item at time t and Z_{jt} is a set of independent variables such as relative price of non-fish to fish, general price index, cost of production, and socio-economic variables etc.

IV.3 General Equilibrium of Fish and Non-fish Markets

Ideally one would like to estimate the parameters of the system of simultaneous equations defined by the demand and supply functions specified above, and that also, with due to cognizance of the biological aspects of fish production. The endogenous variables of the model would not only include QD^{cpf}, QS^{cpf}, QD^{clf}, QS^{clf} QD^{nf}, QS^{nf}, (P^{cpf}/P^{clf}), P^{nf}, but also stock of various species. The exogenous variables would include income, baseline category, programme status, water body type, and percentage of time spent using a particular type of gear. If the values of shock i.e. exogenous variables are changed under a set of assumptions, a new set of equilibrium values would be generated. By comparing the old and the new equilibrium, it would be possible to capture the effect of the change in shock variables on equilibrium values. This mechanism could be employed for the simulation exercise to capture the effect of CBFM since one can argue that CBFM has brought a change in the values of the shock variables, which in turn affected the market outcome. Based on the time path of the exogenous variables, projection of the equilibrium outcome over a given time frame could be made to investigate the probable impact of CBFM type intervention.

While the general framework outlined above had been the basis, the exercise undertaken had to be limited to the supply of fish from the various types of water bodies as captured by the catch monitoring data. In only limited ways, other dataset could be made use of, details of which are discussed in the following section.

V. The Estimation Process and Simulation Design

The primary objective of undertaking a simulation and projection analysis is to investigate the contribution and importance of inland fishery sector in the national economy of Bangladesh. The projection results are also intended for policy makers to enable them to assess the relative benefits and trade offs of alternative management options. The model presented earlier in the previous section is, indeed, the intended model designed to suit a projection analysis. Unfortunately, this model could not be estimated in its entirety due to lack of data. Since the primary source of data (as outlined under the scope of the study) was the three monitoring datasets as well as the baseline and impact survey, it was only possible to estimate the supply of capture fish (QS_{it}^{cpf}) from the available data. One must acknowledge the fact that the monitoring datasets and the baseline and impact surveys were not designed for simulation or projection purposes. As a result, there were serious deficiencies in meeting data requirements for estimation of the model outlined above. Moreover, bio-economic data on wild fish stock was also needed to undertake a meaningful projection analysis, which was not available at the time of undertaking this study. Therefore, data limitation severely constrained the ability to design and estimate a proper model of the fishery sector and the ultimate empirical query under this study became estimating a simplified fish production function for capture fish as a function of variables permitted by parameter estimates from the available data and to conduct simulation exercise on the basis of the estimated supply function.

V.1 Supply of Capture Fish - Estimation

The purpose of the simulation exercise is to be able to project production of inland capture fish. The underlying conceptual framework suggests that supply of fish would depend on its relative price – vis-à-vis cultured fish and (more importantly) vis-à-vis prices of non-fish food items. Influence of projects could only be captured by status of water bodies (project and control). Supply would also depend on the extent of extraction, at least in the short term when (possible) depletion of stock is not yet visible in observed outcomes of catch. The extent of extraction shows up in the number of gears that are active on a unit area (hectare) of water surface, while the changes in stocks are better captured with time variable. In order to make best use of the three sets of monitoring data, the research team generated a panel data that included year-wise months on the time scale and individual water bodies to represent the cross-sections. Some aspects of this panel data are discussed before presenting the regression estimates on supply of capture fish.

Consumption and expenditure data from household monitoring provided information to group various species into capture and culture. The data also permitted construction of 'non-fish food' price, which is a weighted average of prices of all non-fish food items with shares in consumption being used as weights. Similarly, species-wise prices were used to generate prices of capture and culture fish for each month in a year. There were missing observations, and these were filled with commonly acceptable statistical techniques.

Table 1: Description of the Variables of Regression Analysis

Variable	Description
Log of Relative price of capture fish to price of non-fish food	Log of ratio of prices of capture fish and non-fish food prevailing in a month for a water body.
Log of Time spent for fishing	Log of time that increases with the change in month during which the fishing is done.
Log of Gear per ha*	Log of average number of active gears per hectare on a day during the month for a water body.
Log of Area*	Log of the mean area of a water body measured in hectare
Dummy for Project water body	Value is 1 if the water body is a project site and 0 if it is a control site. Captures the difference in mean catch (controlling for all other variables) between project site and control site.
Dummy for Open Beels*	Value is 1 if the water body is an open beel and 0 otherwise. Captures the difference in mean catch (controlling for all other variables) between open beel and river.
Dummy for Closed Beels*	Value is 1 if the water body is a closed beel and 0 otherwise. Captures the difference in mean catch (controlling for all other variables) between closed beel and river.
Dummy for Flood Plain Beels*	Value is 1 if the water body is a flood plane beel and 0 otherwise. Captures the difference in mean catch (controlling for all other variables) between flood plane beel and river.
Dummy for Open Beel type Project water body*	Value 1 if the water body is an open beel and a project site and 0 otherwise. Captures the difference in mean catch (controlling for all other variables) between open beel and river among the project sites.
Dummy for Closed Beel type Project water body*	Value 1 if the water body is a closed beel and a project site and 0 otherwise. Captures the difference in mean catch (controlling for all other variables) between closed beel and river among the project sites.
Dummy for Flood Plain Beel type Project water body	Value 1 if the water body is a flood plane beel and a project site and 0 otherwise. Captures the difference in mean catch (controlling for all other variables) between flood plane beel and river among the project sites.
Area of Open Beels*	The value is equal to the area of the water body if it is an open beel and 0 otherwise. Captures the variation in catch as the water body size changes among the open beels.
Area of Closed Beels*	The value is equal to the area of the water body if it is a closed beel and 0 otherwise. Captures the variation in catch as the water body size changes among the closed beels.
Area of Flood Plain Beels	The value is equal to the area of the water body if it is a flood plane beel and 0 otherwise. Captures the variation in catch as the water body size changes among the flood plane beels.
Dummy for Dry season	The value is 1 if the month is between November to April and 0 otherwise. Captures the difference in mean catch between the periods November-April and May-October.
Dummy for Dry season and Open Beels *	The value is 1 if the month is between November to April and the water body is an open beel and 0 otherwise. Captures the difference in mean catch between the periods November-April and May-October among the open beels.
Dummy for Dry season and Closed Beels	The value is 1 if the month is between November to April and the water body is a closed beel and 0 otherwise. Captures the difference in mean catch between the periods November-April and May-October among the closed beels.
Dummy for Dry season and Flood Plain Beels	The value is 1 if the month is between November to April and the water body is a flood plane beel and 0 otherwise. Captures the difference in mean catch between the periods November-April and May-October among the flood plane beels.
Log of Quantity of capture fish supply per day	Log of average quantity of capture fish caught on a day during a month in a water body.

In the estimated Catch (supply) function of inland capture fish, the **dependent variable** was measured as total catch of capture fish (in log natural of kg). The **exogenous variables** were one dummy variable for project status, three dummy variables for open beel, closed beel and flood plain beel (with rivers as reference), three dummy variables for interaction between project status and water body types, ratio of price of capture fish to price of non-fish food (in log natural), time (in log natural of months), number of active gears per hectare of water body (log natural) and area (in log natural of hectare). A detail explanation of the variables is provided in table 1.

The findings of the regression analysis are presented in Table 2 below.

Table 2: Regression Estimates
Dependent Variable: Log of catch of capture fish, daily by water body

Description of Variables	Coefficients	t-value	Significance level
(Constant)	0.6020	1.1170	0.2647
log of Relative price of capture fish to price of non-fish food	0.0165	0.2612	0.7941
log of Time spent for fishing	-0.0344	-0.5482	0.5839
log of Gear per ha*	1.1031	21.4027	0.0000
log of Area*	1.1681	12.0143	0.0000
Dummy for Project water body	-0.1806	-1.0533	0.2929
Dummy for Open Beels*	-1.3694	-4.2335	0.0000
Dummy for Closed Beels*	-11.9076	-6.6929	0.0000
Dummy for Flood Plain Beels*	-2.0349	-7.2106	0.0000
Dummy for Open Beel type Project water body*	0.7517	2.7701	0.0059
Dummy for Closed Beel type Project water body*	6.5608	5.3610	0.0000
Dummy for Flood Plain Beel type Project water body	0.5117	1.7478	0.0813
Area of Open Beels*	-0.0044	-4.0857	0.0001
Area of Closed Beels*	0.1710	5.7777	0.0000
Area of Flood Plain Beels	-0.0007	-1.0864	0.2780
Dummy for Dry season (November to April)	-0.0426	-0.2841	0.7765
Dummy for Dry season and Open Beels *	0.5560	2.4949	0.0130
Dummy for Dry season and Closed Beels	0.3004	1.0571	0.2911
Dummy for Dry season and Flood Plain Beels	0.2127	0.8821	0.3783
Dependent Variable: log of quantity of capture fish supply per day			
Adjusted R-square = 0.76			

Note: Those variables with * have coefficient estimates that are statistically significant at 5% or less (that is, figures in the last column are less or equal to 0.05)

In the estimated regression results, the sign of the coefficient for the ratio of price of capture fish to price of non-fish is positive implying that catch of capture fish responds positively to a rise in the price of capture fish compared to non-fish food items. However, the coefficient is not statistically significant shown by the large significance level. Here, time spent for fishing is negatively related with fish production with a statistically insignificant coefficient estimate. Number of active gears per hectare is positively related with fish production and has a statistically significant coefficient. Area of the water body is positively related with output and also has a statistically significant coefficient.

The base for comparison in this estimated function is river. The negative sign of the estimated coefficients for the open beels, closed beels and flood plain beels indicate that the production of these types of water bodies is lower than that of rivers. These are also statistically significant. The positive sign of the coefficients for project water bodies of open beels, closed beels and flood plain beels imply that fish production is higher in the project water bodies of these types. However, the coefficients for the open and closed beels are statistically significant at 5% whereas the coefficient for flood plain beels is not. Interaction terms of area and water body type show that fish production decreases for open beels and flood plain beels as area increases whereas production is positively related with area for closed beels. Here, the coefficients are statistically significant for open and closed beels. The coefficient for the dry season has a negative sign meaning output is estimated to be lower in dry season. However, it is not statistically significant. When interaction variables are taken between dry season and water body types, it is seen that production is higher in all three types of water bodies during the dry season. Out of these, the coefficient is estimated to be statistically significant for open beels only. The adjusted R-square of this estimated regression is quite high indicating a good fit of the data.

V.2 Simulation Design

Given the reality of data, an attempt has been made to outline some possible simulation and projection scenarios under a set of assumptions regarding the growth of the exogenous variables with **2005 as the base year**. In the simplified supply function, there are several sets of shock variables through which one can try to trace the impacts of CBFM type intervention. These **shock variables** are:

- Relative price of capture fish to price of non-fish food items (to be affected by changes in income);
- Percentage growth in total area under different types of water bodies;
- Percentage growth in mean area under different types of water bodies;
- Percentage growth in project area under different types of water bodies;
- Annual growth in active number of gears per hectare;

V.2.1 Changes in the Relative Price

Depending on the direction and magnitude of assumed changes in these exogenous variables, a number of alternatives could be generated. With respect to **relative price**, it is expected that the relative price of capture fish to price of non-fish food items would be affected by changes in income. Based on adjusted values of expenditure and supply elasticities of capture fishery used in Bangladesh country model of Asia Fish Model (Madan Dey (et. al), it has been estimated that the price of capture fish would increase by approximately 4.368 percent for 6.2 percent rise in income whereas price of non-fish items was estimated to go up by 3.1% for the given increase in income (workings in the annex). This gives us a 1.41% growth rate in the ratio of price of capture fish to price of non-fish food items. This has been treated as the Business As Usual (BAU) value for the relative price, i.e. if everything continues as they are in 2005, the relative price would rise at a rate of 1.41% during the projection period. Two other alternative values for the relative price of fish to non-fish have been presented here; these are based on scenarios where high productivity growth in culture fishery depresses the increase in the price of capture fish and as a result there is no change (growth rate = 0%) in the relative price of capture fish. This is the optimistic scenario about fish production in Bangladesh. On the other extreme end is the case of slower technical progress in culture fishing such that the rate of increase in the relative price further accelerates above 1.41%. To represent this scenario, a 2.5% growth rate in the relative price has been used for some alternative scenarios (see Table 2).

V.2.2 Changes in the Total and Mean Area of Water Bodies

The business as usual growth rate indicating continuation of the scenario in 2005 for **total area and mean area** of different types of water bodies is obviously zero. This implies that the present size of water bodies in total and mean terms would continue in future and hence the rate of growth in total and mean areas would be zero. The plausible alternative values have been assumed as negative, i.e. there would be overall decline in total as well as mean area of water bodies. This assumption is justified by reality where a large area of fish habitat has been gradually removed due to encroachment, construction of embankment, infrastructure and siltation of rivers. Given this situation, some scenarios have been constructed where there would be one percent decline in the total area of open beels, flood plain beels and rivers. The assumed decline for closed beels is smaller (0.5 percent) to reflect the possibility that as some water bodies (such as open beels) become smaller in size (due to encroachment or other reasons), these might effectively be considered as closed beel-type of water bodies.

Similarly, the mean area of water bodies is also likely decline in future together with the total area. However, the reduction in the mean area might be smaller that the reduction in the total area. This is based on the argument that some water bodies would be completely removed from fish habitat leading to a decline in the total area of water bodies; but the average size of water bodies may remain largely unaffected by this reduction in the total area. The decline in the mean area of rivers has been assumed to be smaller for obvious reasons.

It must be acknowledged here that the assumed magnitude of decline in the total and mean area of the different types of water bodies is rather arbitrary. Not all water bodies are likely to decline/change at the same rate in real life. It is quite plausible that as some types of water bodies experience reduction in total/average size, other types of water bodies experience increase in their number/average size. For instances, increased demand for homesteads or agricultural land may reduce area under beels. It is also quite possible that new embankments will reduce area under open beels even though some of it may get converted to closed beels. The rate of decline of different types of water bodies could be estimated from time series data on size/area of the various types of water bodies. In the absence of such time series data of the size of water bodies and hence lack of a correlation analysis, it has been assumed rather arbitrarily that the total and mean area of the four types of water bodies would decline at the rates given in Table 2.

V.2.3 Changes in Project Area

The issue of **scaling up** of CBFM into other water bodies of the country would be captured through the shock/exogenous variable – **percentage growth** in project area under different types of water bodies. The business as usual case represents the scenario of 2005, i.e. the continuation of the scale of operation of 2005 in future (till 2015). This situation of **no (or zero) scaling up** is shown by the cases where the assumed rate of change in the project area under different types of water bodies is zero. The alternative values where the **rate of change is positive** for percentage of project area reflect the possibility of expansion or **scaling up** of CBFM 2 type of intervention. It has been assumed that the project area would expand at a rate of 5 or 10 percent, except for the cases of rivers. The share of river under project has been assumed to stagnate and hence the rate of change is zero percent. This is based on the understanding that it is difficult to compare across project and control sites in the case of rivers due to the size factor. The assumed rates of growth show the probable effects of expanding CBFM-type management to 5 or 10 percent more water bodies compared to the scale of operation in 2005. In the limit, if CBFM practice were introduced in all water bodies of the country, the rate of growth in percentage of project area would need to be very high. The implication of such expansion on fish production is not hard to imagine; it would simply be a few multiples of the projected impacts of 5 or 10 percent growth in project areas.

The BAU scenario considered earlier raises possibilities of alternative perspectives. One may consider it to be synonymous with 'complete stoppage of all CBFM activities' or 'sustenance of CBFM activities at their current levels'. Obviously, assumptions on sustaining the achievements at their current levels without or with BAU engagements are critical. Since no additional information is available to infer on the need (as well as the size) of CBFM engagement to sustain current achievement, one may only conjecture on the 'No-CBFM' scenario. It is our understanding that the outcomes are not symmetric – that is, outcomes from 5% increase in area under CBFM is not equivalent to the negative outcome of a decline in 5% of area under CBFM. On the contrary, there are reasons to believe that parts of the gains already made (and attributable to CBFM) will be sustained even in the absence of CBFM (that is, complete withdrawal of the project). Such a perspective lends support to the possibility that the future gains from CBFM may be more than that estimated in the current exercise.

V.2.4 Changes in Active Gears

The business as usual rate of change (or continuation of the situation in 2005) for number of active gears has been assumed as 5 percent. This has been based on a downward adjusted value of the parameter estimated from gear census to take into consideration the effect of extreme values. The alternative value indicates a slower growth rate in the number of active gears per hectare. This assumption is justified on two grounds. Firstly, it is beyond doubt that capture fishery is already over-exploited and hence it is unlikely that growth rate in the number of gears would accelerate in future. Secondly, data on number of persons per gear shows a declining trend across different types of water bodies (graphs in annex). As a result, it is likely that number of gears per hectare has perhaps reached the peak and the growth would slow down in future as size of water bodies decline.

Table 3: Exogenous Variables and their Alternative Values for the Rate of Change

Exogenous variables	Base Scenario (2005)	Assumed Change in the Growth Rate (%)	
		Business As Usual value	Alternative Values
Relative price of fish to non-fish	0.8264	1.41	0 (optimistic), 2.5 (pessimistic)
Total area under Open Beel	114315.2 hectare	0	-1
Total area under Closed Beel	5406.48 hectare	0	-0.5
Total area under Flood Plain Beel	2846315 hectare	0	-1
Total area under River	1032271 hectare	0	-1
Mean area under Open Beel	95.08 hectare	0	-0.1
Mean area under Closed Beel	66.13 hectare	0	-0.1
Mean area under Flood Plain Beel	166.22 hectare	0	-0.1
Mean area under River	572.29 hectare	0	-0.5
Percentage of project area under Open Beel	3.41%	0	5 10
Percentage of project area under Closed Beel	15.90%	0	5 10
Percentage of project area under Flood Plain Beel	0.15%	0	5 10
Percentage of project area under River	1.39%	0	0
Percentage area in project (all)	0.24%	0	1.92 3.84
Number of active gears per hectare	1.2922	5	3

Given these alternative values of the exogenous and shock variables, a number of simulation and projection scenarios for fish production could be generated by taking a set of combination of these values. Out of many different possibilities, the following five scenarios have been selected for simulation and projection analysis.

Scenario 1
The first simulation exercise is a combination of the business as usual values of the exogenous variables listed in the Table 2. It reflects the situation where the relative price and the number of active gears continue to grow at their base values of 2005 throughout the projection period till 2015 while there is no change in the total area, mean area as well as in percentage of project areas of water bodies.

Scenario 2
The second scenario is slightly different from scenario 1. The only difference between these two scenarios is that the rate of growth of number of active gears is assumed to be slower (3%) than the base rate (5%). Other exogenous variables have been assumed to change at the same rate as in scenario 1. Specifically, it is assumed that relative of price of fish to non-fish would grow at 1.41 percent and there would be no change in the total area, mean area and in percentage area of project water bodies.

Scenario 3
This scenario reflects the optimistic case of rapid growth in culture fisheries such that the assumed rate of change in the relative price of fish to non-fish is zero. This is combined with alternative values of the other exogenous variables. Here, it has been assumed that total area and mean area of the water bodies would decline (at the alternative values). At the same time, the percentage area under project would expand, i.e. CBFM practice is scaled up to 5% more areas. These changes are combined with the assumption of slower growth (3%) in active gears.

Scenario 4
This scenario is broadly similar to scenario 3 except for the fact that it reflects a pessimistic case of slow growth in culture fisheries. This is reflected in the higher assumed rate of change in the relative price of fish to non-fish (2.5%) compared to the base scenario (1.41%). All other exogenous variables grow at the rates outlined under scenario 3, i.e. there is decline in the total as well as mean area of water bodies while percentage of project area expands at a rate of 5 percent.

Scenario 5
In this scenario the relative price and number of active gears grow at their base values of 1.41% and 5%, respectively. It is combined with a decline in the total and mean area of water bodies as given under scenarios 3 and 4. However, percentage of area under project increases at a rate of 10%. This represents the plausibility of faster expansion of CBFM practice than outlined in scenarios 3 or 4.

Table 4: Summary of Scenario Values

Exogenous variables	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Relative price of fish to non-fish	1.41%	1.41%	0%	2.5%	1.41%
Total area under Open Beel	0%	0%	-1%	-1%	-1%
Total area under Closed Beel	0%	0%	-0.5%	-0.5%	-0.5%
Total area under Flood Plain Beel	0%	0%	-1%	-1%	-1%
Total area under River	0%	0%	-1%	-1%	-1%
Mean area under Open Beel	0%	0%	-0.1%	-0.1%	-0.1%
Mean area under Closed Beel	0%	0%	-0.1%	-0.1%	-0.1%
Mean area under Flood Plain Beel	0%	0%	-0.1%	-0.1%	-0.1%
Mean area under River	0%	0%	-0.5%	-0.5%	-0.5%
Percentage of project area under Open Beel	0%	0%	5%	5%	10%
Percentage of project area under Closed Beel	0%	0%	5%	5%	10%
Percentage of project area under Flood Plain Beel	0%	0%	5%	5%	10%
Percentage of project area under River	0%	0%	0%	0%	0%
Percentage area in project (all)	0%	0%	01.92%	1.92%	3.84%
Number of active gears per hectare	5%	3%	3%	3%	5%

VI. Results

Discussion and comparison of the simulation and projection results are presented in this section. On the basis of the projected values under the five different scenarios, at attempt has been made to estimate the impact at the national level in terms of contribution to GDP, changes in household expenditure and the resulting impact on poverty scenario. The last two exercises have been carried out using the Social Accounting Matrix of 2000.

VI.1 Simulation and Projection Results

As discussed above, scenario 1 involves a case where the relative price grows at 1.41%, number of active gear grows at 5% and there is no change in the total, average as well as project areas (no scaling up) compared to the base year (2005). Under this scenario, the estimated impact on daily catch of capture fish for the four types of water bodies is shown in Table 4.

Table 5: Projection Results under Scenario 1

Scenario 1											
	Total Catch of Capture Fish (%)										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
OB	100.00	104.37	109.24	114.53	120.21	126.27	132.71	139.56	146.80	154.48	162.59
CB	100.00	104.37	109.24	114.53	120.21	126.27	132.71	139.56	146.80	154.48	162.59
FPB	100.00	104.37	109.24	114.53	120.21	126.27	132.71	139.56	146.80	154.48	162.59
Rivers	100.00	104.37	109.24	114.53	120.21	126.27	132.71	139.56	146.80	154.48	162.59
All	100.00	104.37	109.24	114.53	120.21	126.27	132.71	139.56	146.80	154.48	162.59

It is seen from the above table that daily output of capture fishery is estimated to increase throughout the projection period. It is important to note here that total catch is uniformly increasing across all types of water bodies, as relative price of fish to non-fish food items and number of active gears increase at base values holding the present size of water bodies and current scale of project operation stagnant. This result shows that the effect of a change in the relative price and active gears is same for all types of water bodies. According to the simulation results, fish catch from capture sources is projected to more than double (62.59% higher) by the year 2015 compared to 2005. These projected values are the basic reference outcomes against which simulation results of other scenarios would be compared and analyzed.

Table 6: Projection Results under Scenario 2

Scenario 2											
	Total Catch of Capture Fish (%)										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
OB	100.00	102.18	104.70	107.47	110.43	113.56	116.85	120.30	123.89	127.63	131.51
CB	100.00	102.18	104.70	107.47	110.43	113.56	116.85	120.30	123.89	127.63	131.51
FPB	100.00	102.18	104.70	107.47	110.43	113.56	116.85	120.30	123.89	127.63	131.51
Rivers	100.00	102.18	104.70	107.47	110.43	113.56	116.85	120.30	123.89	127.63	131.51
All	100.00	102.18	104.70	107.47	110.43	113.56	116.85	120.30	123.89	127.63	131.51

The projection results of scenario 2 are present above. Under this scenario, total catch of fish from capture sources also uniformly increases throughout the projection period as observed in scenario 1. The reason for the uniform increase is same, i.e. the effect of changes in the relative price and active gears in operation is equivalent irrespective of the type of water body. However, the year-to-year increase in catch is relatively smaller compared to scenario 1. This is due to the slower rate (3% compared to base value of 5%) of growth in number of active gears. It has been estimated in the regression analysis that number of active gears is positively and significantly related to catch of fish. Hence, when we assume that growth in gears would be slower, it automatically slows down the rate of increase in catch of fish. At the end of the terminal year (2015), output is estimated to be 31.51% higher compared to 2005. This increase in output is, however, 31.08% lower than the projected results of scenario 1 due to the slower growth in active gears.

Table 7: Projection Results under Scenario 3

Scenario 3											
					Total Catch of Capture Fish (%)						
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
OB	100.00	102.33	105.02	107.96	111.12	114.47	118.01	121.71	125.60	129.66	133.89
CB	100.00	106.42	113.86	122.37	132.03	143.01	155.49	169.70	185.94	204.54	225.92
FPB	100.00	106.42	113.86	122.37	132.03	143.01	155.49	169.70	185.94	204.54	225.92
Rivers	100.00	102.16	104.65	107.39	110.32	113.43	116.69	120.10	123.65	127.35	131.20
All	100.00	102.53	105.45	108.69	112.21	116.01	120.07	124.43	129.10	134.12	139.51

The results of scenario 3 are presented in table 6. Scenario 3 describes a case where relative price of fish to non-fish food items remains at the base year's level (i.e. rate of growth 0%) while total and mean area of all types of water bodies declines (negative growth rate). At the same time, CBFM practice is scaled up to 5% more areas with slower growth in active gears. These changes affect output of capture fishery in different ways. For example, since catch is positively related with relative price (even though the coefficient is statistically insignificant), the stagnant price ratio would reduce fish catch. Similar effect would be observed with respect to changes in total and mean area since area is also estimated to be positively related with output. However, the dummy variables for project water bodies of open beels, closed beels and flood plain beels have positive coefficients. As a result, scaling up of CBFM by 5% is likely to positively affect output from capture fishery. The size of the estimated coefficients tells that the effect would be larger for project water bodies of closed beels. Altogether, some of the assumed changes will affect fish catch negatively while some others will affect positively. The direction of actual change in fish output, therefore, depends on the relative strength of these opposing forces. The results here indicate that the positive forces are dominant and hence average output was estimated to increase by 39.51% in 2015 compared to 2005.

It is seen from the results that fish catch from capture sources is increasing throughout the projection period. However, some important differences could be observed when compared with the results of the scenarios 1 and 2. It is observed that the increase in output under scenario 3 is slightly higher (by a few percentage points) for open beel type of water bodies compared to those under scenario 2. The increase is significantly higher under scenario 3 for closed beels and flood plain beels whereas the increase in output from rivers is estimated to be lower under scenario 3. This result could be explained in the light of the estimated size of the coefficients for project water bodies in the regression equation. When compared with the scenario 1, it is seen that the projected increase in output is lower under scenario 3 for open beels and rivers. Even the though the increase in outputs are higher for closed beels and flood plain beels under scenario 3, but in aggregate the average increase in output for all types of water bodies has been projected to be lower than scenario 1. The depressed relative price, slower growth of gears, reduction in the size of the water bodies – all of these factors negatively affected catch of capture fishery more than the positive effects of scaling up CBFM practices to more water bodies.

Table 8: Projection Results under Scenario 4

Scenario 4											
Total Catch of Capture Fish (%)											
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
OB	100.00	102.37	105.10	108.09	111.30	114.71	118.29	122.06	126.01	130.13	134.44
CB	100.00	106.46	113.95	122.52	132.25	143.30	155.87	170.19	186.54	205.29	226.85
FPB	100.00	106.46	113.95	122.52	132.25	143.30	155.87	170.19	186.54	205.29	226.85
Rivers	100.00	102.20	104.74	107.52	110.50	113.66	116.97	120.44	124.06	127.82	131.73
All	100.00	102.57	105.54	108.83	112.40	116.24	120.37	124.79	129.52	134.61	140.08

Under the fourth scenario, higher productivity in culture fishery leads to a rise in the growth rate of the relative price of fish to non-fish to 2.5%. Other exogenous variables maintain the values presented in scenario 3 where it has been assumed that there would be slower growth in gear usage, decline in total and mean area and expansion of CBFM practices. The projection results show minor changes in the figures compared to scenario 3; output is estimated to be slightly higher (by less than a percentage point) under the fourth scenario. It indicates the situation where the assumed increase in price is not sufficient to lift output beyond the levels projected under scenario 3 or 1 as the negative effects of slower growth rate of gears and the decline in the size of the water bodies dominate.

Table 9: Projection Results under Scenario 5

Scenario 5											
Total Catch of Capture Fish (%)											
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
OB	100.00	104.68	109.92	115.65	121.84	128.52	135.69	143.39	151.66	160.53	170.05
CB	100.00	114.54	132.95	156.36	186.44	225.60	277.35	346.92	442.20	575.41	765.88
FPB	100.00	114.54	132.95	156.36	186.44	225.60	277.35	346.92	442.20	575.41	765.88
Rivers	100.00	104.37	109.24	114.52	120.20	126.26	132.70	139.54	146.78	154.45	162.56
All	100.00	105.22	111.22	118.02	125.75	134.59	144.85	156.99	171.68	190.01	213.63

The fifth scenario involves rapid expansion of CBFM practices in a more water bodies. This assumption has been combined with decline in the total and average area of water bodies. The relative price and gear usage have been assumed to grow at their base year's rates (1.41% and 5% respectively). Given these assumptions, a tremendous increase in amounts of catch from capture fishery for all types of water bodies is observed. Here favorable relative price, growing number of gears and rapid expansion of CBFM practices have dominated over the decline in the size of the water bodies and hence output is observed to have increased extraordinarily by 113.63% in 2015 compared to the level in 2005.

VI.2 Economy-wide Impacts of the Projected Changes

Estimation of economy-wide outcomes requires an appropriately designed analytical formulation that establishes linkages among micro-meso-macro levels. In this respect, two separate routes have been envisaged. These are:

- Scaling up technique to estimate the change in the contribution of the fishery sector to GDP; and
- Social Accounting Matrix (SAM) approach.

Under the first initiative, attempts have been made to estimate the increase in the contribution of the fishery sector in GDP given the projected increase in output of inland capture fishery. For the second approach, a recent national Social Accounting Matrix (SAM 2000) estimated under the UNDP/Planning Commission initiative on Sustainable Human Development was utilized to generate economy-wide impacts. Relevant multipliers have been developed to quantify backward, forward and consumption linkages based on the estimated increase in capture fish production which has been adjusted by the share of inland capture fishery.

VI.2.1 Contribution of Capture Fish in GDP

Fish sector's size in the overall economy gives an idea about the importance of this sector. For the last one decade contribution of fish to GDP has been hovering between 5% and 6% with a declining trend since the turn of the millennium. However, the effect of CBFM type management policies does tell a different story for the future.

Table 10: Fish sector's contribution to GDP

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Share of Fish in GDP (%)	5.21	5.36	5.48	5.67	5.93	6.09	5.51	5.40	5.25	5.11	5.00

Source: Bangladesh Economic Survey 2006

GDP shares are estimated on the assumptions that the price of fish as a whole behaves the same way as the price of capture fish; and that GDP, production of culture and marine fish grow respectively at their mean growth rates for the last five years.

Scenario 1

Here price of capture fish is expected to grow at 4.368%. Following this the value of total fish will increase to Taka 36149 cores in 2015. As a result the share of fish in GDP will increase to 7.98% in 2015 from the 2005 level of 5%.

Table 11: Share of Fish in GDP (crore taka)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
GDP	266974	281481	296777	312904	329908	347835	366737	386665	407677	429830	453187
Scenario 1											
Fish	13349	14712	16232	17922	19797	21876	24179	26730	29556	32684	36149
Share of Fish in GDP (%)	5.00%	5.23%	5.47%	5.73%	6.00%	6.29%	6.59%	6.91%	7.25%	7.60%	7.98%
Scenario 2											
Fis h	13349	14596	15983	17517	19211	21081	23143	25417	27925	30690	33739
Share of Fish in GDP (%)	5.00%	5.19%	5.39%	5.60%	5.82%	6.06%	6.31%	6.57%	6.85%	7.14%	7.44%
Scenario 3											
Fish	13349	14437	15637	16954	18396	19975	21702	23592	25660	27925	30406
Share of Fish in GDP (%)	5.00%	5.13%	5.27%	5.42%	5.58%	5.74%	5.92%	6.10%	6.29%	6.50%	6.71%
Scenario 4											
Fish	13349	15090	17084	19361	21959	24922	28301	32157	36558	41584	47326
Share of Fish in GDP (%)	5.00%	5.36%	5.76%	6.19%	6.66%	7.16%	7.72%	8.32%	8.97%	9.67%	10.44%
Scenario 5											
Fish	13349	14757	16341	18123	20130	22397	24972	27919	31327	35324	40106
Share of Fish in GDP (%)	5.00%	5.24%	5.51%	5.79%	6.10%	6.44%	6.81%	7.22%	7.68%	8.22%	8.85%

Scenario 2

Under this scenario price increase is same as scenario 1. However, due to changes in other parameters the production of capture fish will not increase by the same margin and so share of fish in GDP will rise to 7.44%.

Scenario 3

Under scenario 3, it was assumed that the prices of both capture fish and non-fish food items would increase by 3.1% keeping the their relative constant. Since price of capture fish and for that matter price of fish will not increase as much as in previous two cases, the value of fish will be much less in year 2015 compared to that of scenario 1. The share will rise to only 6.71% in 2015.

Scenario 4

Under scenario 4 it was assumed that relative price of capture fish and non-fish food items would rise at 2.50% and this would require price of capture fish to increase by 7.75%. This will also have a positive impact on the production. Together they will push the share of fish in GDP to 10.44% in 2015.

Scenario 5

Under this more optimistic scenario where the price rise is same as scenario 1 and 2 but production being relatively high by assuming favorable changes in other parameters, share of fish in GDP will rise to 8.85% by 2015.

VI.2.2 SAM Approach

For the impact analysis, the exogenous accounts within the SAM model are the ones that are likely to be directly impacted by the change in fish production and CBFM intervention. Within the SAM 2000 model, we can treat one account as exogenous: "Other Fish". The projected increase in the capture fish under the various alternatives would constitute the estimated size of the 'shock' or the increase in final demand. However, the projected values need to be adjusted downward to reflect the fact that inland capture fishery is only a segment of the total fishery sector. It is reported that inland open water fishery accounts for 45.5% (average of 1984-85 to 2004-05) of total fish production in Bangladesh (Statistical Year Book of BBS, various years). Given this proportion, the projected increase in capture fish catch for 2015 compared to 2005 has been adjusted for all the five alternative scenarios to find the size of the increase in the final demand in the 'Other Fish' account (as provided in Table 10).

Table 12: Projected Increase in the Final Demand in "Other Fish" Account of SAM 2000

Scenarios	Difference between projected values of 2015 and 2005 (All water bodies)	Increase in National Demand in SAM Account
1	62.59%	28.48%
2	31.51%	14.34%
3	39.51%	17.98%
4	40.08%	18.24%
5	43.18%	51.70%

VI.2.2.1 Simulation Results for National SAM 2000

On the basis of the above production increase of 28.48% under scenario 1, a simulation exercise has been undertaken with a 28.48 percent demand shock in "other fish" account of SAM 2000. The results are presented below in the Table #.

Table 13: Output, Value Added and Consumption Effects in SAM under Scenarios 1-2

Accounts	Base Year	% Change from Base Year				
		Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Paddy	276588.11	10.47	5.27	6.61	6.71	19.01
Grains	42861.89	12.81	6.45	8.09	8.21	23.26
Jute	32552.79	8.03	4.04	5.07	5.14	14.57
Commercial	228735.25	9.10	4.58	5.75	5.83	16.52
Tea	3686.03	8.32	4.19	5.25	5.33	15.10
Other Crops	34376.99	8.01	4.03	5.05	5.13	14.53

Accounts	Base Year	% Change from Base Year Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Livestock	102735.46	8.12	4.09	5.13	5.20	14.75
Poultry	44401.59	8.50	4.28	5.37	5.44	15.43
Other Fish	160242.19	39.26	19.77	24.79	25.14	71.27
Forestry	68584.06	3.39	1.70	2.14	2.17	6.15
Rice Milling	458921.16	9.10	4.58	5.74	5.83	16.51
Ata and Flour Mill	59536.43	13.22	6.66	8.35	8.47	24.01
Other Food	315802.78	9.20	4.63	5.81	5.89	16.70
Tea Product	6020.19	8.42	4.24	5.32	5.39	15.29
Leather Products	73072.32	8.11	4.08	5.12	5.19	14.72
Jute Textile	44949.36	8.08	4.07	5.10	5.18	14.67
Yarn	55465.74	12.62	6.35	7.96	8.08	22.90
Mill Cloth	55727.78	7.88	3.97	4.97	5.04	14.30
Clothing	78132.49	8.40	4.23	5.30	5.38	15.25
Ready Made Garments	257337.46	7.46	3.76	4.71	4.78	13.54
Tobacco Products	34457.02	8.47	4.27	5.35	5.43	15.38
Wood Products	92066.22	8.48	4.27	5.36	5.43	15.40
Printing and Publishing	13034.23	8.91	4.49	5.63	5.71	16.18
Chemical	129470.79	9.04	4.55	5.71	5.79	16.41
Fertilizer	52672.26	10.39	5.23	6.56	6.65	18.86
Petroleum Products	148636.36	9.62	4.85	6.08	6.16	17.47
Clay Products	26780.48	3.69	1.86	2.33	2.37	6.71
Cement	27706.71	1.49	0.75	0.94	0.95	2.70
Iron and Steel Basic	161653.92	5.84	2.94	3.69	3.74	10.61
Machinery	283884.83	4.31	2.17	2.72	2.76	7.82
Miscellaneous Industry	82202.93	8.76	4.41	5.53	5.61	15.90
Urban Building	73270.20	0.00	0.00	0.00	0.00	0.00
Rural Building	251611.05	0.97	0.49	0.61	0.62	1.76
Construction	68374.56	1.94	0.98	1.22	1.24	3.52
Utility	104228.93	7.49	3.77	4.73	4.80	13.60
Trade Services	410157.95	10.57	5.32	6.67	6.77	19.19
Transport Services	295849.34	8.31	4.19	5.25	5.32	15.09
Housing	284905.87	8.79	4.42	5.55	5.63	15.95
Health	35141.85	8.15	4.10	5.14	5.22	14.79
Education	82151.34	8.26	4.16	5.21	5.29	14.99
Public Administration	125606.14	8.00	4.03	5.05	5.13	14.53
Other Services	343911.86	8.72	4.39	5.51	5.58	15.83
Hotel and Restaurant	29813.75	8.74	4.40	5.52	5.59	15.86
Communications	23800.53	8.52	4.29	5.38	5.46	15.47
Info Tech n Servs	4496.77	7.73	3.89	4.88	4.95	14.03
Total Output Effects	**5585615.95**	**8.90**	**4.48**	**5.62**	**5.70**	**16.15**

Accounts	Base Year	% Change from Base Year Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Male low skilled	694336.98	8.95	4.51	5.65	5.74	16.26
Male high skilled	341448.90	8.53	4.30	5.39	5.46	15.49
Female low skilled	88060.50	8.18	4.12	5.16	5.24	14.84
Female high skilled	16851.55	8.55	4.30	5.40	5.47	15.52
Land	230149.46	14.48	7.29	9.14	9.28	26.29
Capital	875361.00	7.50	3.78	4.73	4.80	13.61
Total Value Added	**2246208.39**	**8.86**	**4.46**	**5.59**	**5.67**	**16.08**
Landless HH	138202.13	8.84	4.45	5.58	5.66	16.05
Marginal Farmer HH	75089.20	8.64	4.35	5.45	5.53	15.68
Small Farmer HH	214196.08	9.38	4.72	5.92	6.01	17.03
Large Farmer HH	197478.64	11.15	5.62	7.04	7.14	20.25
Non agriculture HH	581759.46	8.68	4.37	5.48	5.56	15.75
Illiterate HH	240457.17	8.44	4.25	5.33	5.40	15.31
Low educated HH	291527.11	8.67	4.36	5.47	5.55	15.73
Medium educated HH	338752.40	8.39	4.22	5.30	5.37	15.23
High educated HH	152348.88	8.78	4.42	5.54	5.62	15.93
Total Consumption	**2229811.08**	**8.91**	**4.49**	**5.62**	**5.71**	**16.17**

Output, Value Added and Consumption Effects in SAM under Scenario 1

These results show that in response to a 28.48 percent demand intervention in the "other fish" account under scenario 1, total output of the economy increased by 8.9 percent compared to the base year (ignoring price effects). This is the total output effect. In order to supply the increased outputs, demand for primary factors (i.e. labor, land and capital) increased and hence payments to primary factors also increased by 8.86 percent. This is the value-added effect. The growth of factor returns was the highest for land (14.48%) followed by male low skilled (8.95%). It is interesting to note that the distribution of value added effects is almost evenly distributed across all types of labor. The increased factor payments in turn would imply a rise in household income, part of which would be spent on various goods and services and the rest would be savings. The household consumption expenditure increased by 8.91 percent as a result of the rise in household income. Here the highest increase in spending was by the large farmers (11.15%) followed by small farmers. Again, all other types of households also benefited similarly from the increase in factor demand. It is worth noting here that the focus needs to be placed on the desirable sign of changes in the variables of interest. It is seen in the above simulation exercise that all the various types of factors (particularly labor) and households benefit positively and closely due to the estimated increase in fish production.

Output, Value Added and Consumption Effects in SAM under Scenario 2

According to the simulation results, total national output increased by 4.48 percent compared to the base year (ignoring price effects) due to a 14.34 percent increase in fish production in scenario 2. The resulting increase in factor payments in the economy was 4.46 percent. The increase in household consumption expenditure was 4.49 percent. As expected, the size of the effects is smaller under scenario 2 compared to scenario 1 due to the smaller projected increase in fish production under scenario 2. The distribution of benefits indicates similar pattern found under scenario 1. Even though large farmer households benefit the most, other types of households including the poorer ones also closely benefit from the increase in fish production.

Output, Value Added and Consumption Effects in SAM under Scenarios 3 and 4

It is seen from the simulation results of scenarios 3 and 4 that national output is estimated to increase by 5.62 percent and 5.7 percent respectively. As a result of the increase in output, factor returns and household expenditure were estimated to go up by approximately similar magnitude. These effects are larger in magnitude compared to the simulation results of scenario 2, but are smaller than those of scenario 1. Again, this is expected and explained by the relative magnitude of the increase in national demand that has been used under the different scenarios.

Output, Value Added and Consumption Effects in SAM under Scenario 5

It is observed that the magnitudes of the three multiplier effects are significantly higher in scenario 5 than the simulation results of all other scenarios. However, this is due to larger increase in national demand for 'Other Fish' due to the tremendous projected rise in fish catch. It is seen that national output might increase by as much as 16.15%, factor payments by 16.08% and household expenditure by 16.17% due to the 113.63% rise in fish catch under scenario 5.

VI.2.3 Poverty Impacts

In all the five simulation exercises conducted above, expenditure of all types of households increased. This increase in household expenditure if inputted into a poverty model would be able to estimate the implications on the national poverty scenario. Information regarding base poverty scenario together with the changes in consumption from the simulations of SAM have been used to estimate poverty effects of the projected increase in capture fish production. The estimated poverty effects are compared with the base scenario to quantify the change. The base poverty scenario is presented in Table 14 and is adapted from Luppino et al (2004).

Table 14: Poverty Status by Household Groups – Base Scenario (2000)

Household Groups	Head Count Poverty Measure (%)	Per capita expenditure (Tk.)
Landless	75.70	549.04
Marginal farmer	64.60	649.07
Small farmer	46.58	766.88
Large farmer	25.34	961.23
Non-Agricultural	56.86	706.13
Illiterate	63.61	834.9
Low educated	29.40	1266.97
Medium educated	7.41	1990.13
High educated	0.00	3058.77
All BD households	46.69	944.06

When the changes in consumption are utilized for the simulation exercise within the framework of the national SAM, it is seen that all the socio-economic groups benefit from the activities of CBFM – 2. However, the distribution of poverty reduction is not uniform across the groups as seen in Table 5.10.

Table 15: Changes in Poverty in Bangladesh as a result of an increase in catch of capture fish – Results of Simulation with National SAM under different scenarios

Household Groups	**Percentage change in poverty (over 2005-2015)**				
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Landless	-5.90	-2.81	-3.69	-3.69	-11.02
Marginal Farmer	-25.08	-12.15	-15.20	-15.82	-44.94
Small farmer	-14.68	-7.15	-9.68	-9.68	-26.81
Large Farmer	-23.09	-11.76	-15.23	-15.23	-39.27
Non Agri	-13.47	-7.86	-9.25	-9.25	-22.55
Illiterate	-12.64	-6.49	-7.70	-8.32	-22.65
Low educated	-16.63	-8.98	-10.10	-11.19	-27.93
Medium educated	-30.36	-16.60	-19.84	-19.84	-49.39
High educated	00.00	00.00	00.00	00.00	00.00
All	-11.57	-5.68	-7.37	-7.37	-20.60

It is seen that medium educated, marginal and large farmers registered the highest reductions in poverty under the simulated results of scenario 1. Small farmers, non-agricultural group (poor and non-poor), alliterated as well as low educated also registered significant reduction in poverty, even though the highest increase in consumption was for the large farmers. Here, poverty reduction was less for the landless farmers. Overall, it has been estimated that national poverty level for all Bangladeshi households decreased by 11.57 percent for the estimated rise in consumption expenditure of 8.91 percent.

Similar results are found for scenario 2. Again it is found that medium educated, marginal and large farmers benefit more than any other type of households with landless farmers registering lower reduction in poverty. Overall, it has been estimated that national poverty level for all Bangladeshi households decreased by 5.68 percent for the estimated rise in consumption expenditure of 4.49 percent. As expected, the magnitudes of these reductions in poverty are lower when compared with those of scenario 1.

It is seen here that due to a 5.62 percent increase in expenditure of all households, national poverty would reduce by an estimated amount of 7.37 percent under scenario 3. Here, medium educated households benefited most registering the highest reduction in poverty. This group was followed by large farm households, marginal farmers, low educated households, small farmers and non-agricultural households. Obviously these estimated reductions are larger compared to those of scenario 2, but lower than the results found under scenario 1.

Overall, it has been estimated that national poverty level for all Bangladeshi households decreased by 7.37 percent for the estimated rise in consumption expenditure of 5.71 percent under scenario 4. It is worth noting that the estimated overall decline in national poverty under scenario 4 is same as under scenario 3 even though the percentage change in per capita expenditure is slightly higher (by 0.09 percent) under the fourth scenario. The distribution of poverty reduction also shows the broad trends found under earlier simulation exercise of scenario 3. However, there are a few interesting differences. It is observed that marginal farmers, illiterate households and low educated households experience higher reductions in poverty under scenario 4 compared to those under scenario 3.

For the fifth scenario, it has been estimated that national poverty level for all Bangladeshi households would decrease by 20.6 percent for the estimated rise in consumption expenditure of 16.17 percent. Even though the distribution of the reduction in poverty shows similar trends found in earlier scenarios, but there are some important differences in the results. The overall reduction in national poverty is obviously higher under scenario 5 than scenario 4 or 3 or 2 or 1. However, not all groups benefit equally from the rise in per capita expenditure. As one moves from scenario 4 to 5, it is observed that the landless farmers experienced significant reduction in poverty compared to the rise in income and the status of poverty simulated under scenario 4. This result indicates possibility of a huge reduction in poverty level among all the households based on the assumptions made regarding the key exogenous variables.

VII. Concluding Remarks

The original objective of the present study was to estimate a multi-market equilibrium solution of the inland capture fishery based on which projection exercise of fish production into future would be carried out. Limitations of data restricted estimation of a proper model to capture the effect of CBFM intervention, as an analysis on the demand side of the fish market could not be undertaken. As a result, the objective of projection was carried out under a rather simplified and partial manner. However, the estimated supply function of total catch from capture sources did reveal some interesting features. In particular, the following findings were worth noticing:

- Project water bodies of closed beels, open beels and flood plain beels were found to have higher catch of fish compared to control sites. The results are more statistically significant for closed beels and open beels.
- During the dry season (November to April), catch from closed beels, open beels and flood plain beels was found to be higher compared to rivers. However, the result was statistically significant for open beels only.
- It was found that production of capture fish would increase as relative price of capture fish increases, but the result was not statistically significant. This suggests that supply of capture fish, associated with extraction of natural resources, may also respond to poverty situation.
- If the state of affairs remain as they were in 2005, capture fish production is projected to be 62.59% higher in 2015 compared to 2005.
- If the rate of increase in number of active gears per hectare slows down (compared to the rate in 2005), the increase in the supply of capture fish would be lower than the business-as-usual scenario.
- Even though slower growth rate of gear usage, stagnant price and reduction in the size of the water bodies lower the rate of growth in supply of capture fish, scaling up of CBFM practice to more water bodies was projected to increase catch of capture fish more than the estimated reductions. It was reflected in the higher percentage increases in the projection results of scenario 3 compared to scenario 2.
- The simulation results of scenario 4 indicate that rise (of 2.5%) in the rate of growth of relative price of fish to non-fish food item would not be sufficient to boost catch of capture fish.
- However, constant rates of growth of relative price and gear usage (at the base values) together with more scaled up CBFM activities have the potential to significantly increase production of capture fish even if size of water bodies decline (scenario 5).
- Due to the projected rise in catch of capture fish under the various scenarios, share of fishery sector in GDP is estimated to rise (compared to its share in 2005) as well. However, the extent of the rise depends to a great extent on the relative price of fish to non-fish food items, area of water bodies and the scale of operation of CBFM activities.
- Simulation exercises within the SAM framework indicate that total national output, factor payments and household expenditure are expected to (individually)

increase between a range of 4 to 16 percent. The distribution of benefits tends to favor the large and small farmers.

- Current design of SAM assumes water bodies to be owned by rural large and marginal farmer households, and certain urban groups have biases towards higher fish consumption. It is therefore expected that the largest declines in poverty occurred for these groups compared to other household groups due to the projected rise in catch of capture fish. As one would expect, the results also show that landless farmers would register the lowest reduction in their poverty level in all the alternative scenarios.

References:

Bangladesh Bureau of Statistics, *Statistical Yearbook of Bangladesh*, Various issues.

Blake, B. et. al (2004), "Community Based Fisheries Management, Project 2 (CBFM-2): Third Output to Purpose Review Report"

Briones, R.M. et. Al (2005), "Globalization and Fisheries: Welfare Implications of Export Trade in Asia", Paper presented at the International Workshop on *Globalization and Trade: Implications for Water and Food Security*, Costa Rica

Delgado, C., N. Wada, M. Rosegrant, S. Meijer and M. Ahmed (2003), *Fish to 2020: Supply and Demand in Changing Global Environments*, International Food Policy Research Institute and WorldFish Center: Washington, D.C.

Dey, M. et. Al (2004), "Disaggregated Projections on Supply, Demand, and Trade for Developing Asia: Preliminary Results from the AsiaFish Model", Paper Presented at the IIFET, Japan.

Islam, A. and S. Begum (2006), "Assessing Economy-wide Impacts of Micro Intervention in the Inland Fishery Sector: A Case Study of Community-Based Fishery Management (CBFM) in Bangladesh", Report Prepared for WorldFish Center, Bangladesh.

Luppino, M. et. al (2004), "Estimating the Impacts of the Jamuna Bridge on Poverty Levels in Bangladesh Using SAM and CGE Models: A Comparative Study", The Louis Berger Group, Inc., Washington D.C.

Annex A: Terms of Reference

The WorldFish Center has been implementing community based fisheries management approaches since 1995 in partnership with the Department of Fisheries, Ministry of Fisheries and Livestock and 11 national NGOs. Although it is clear from the experiments of the WorldFish assisted CBFM-1&2 projects and other projects of the government that the CBFM approaches have impacts at the micro level, the macro level impacts is yet to be analyzed as to how important and what role these resource system play in the economy. Drawing lessons from the micro level evidences, WorldFish is interested to understand the macro-economic impacts of the CBFM type intervention in all the waterbodies of the country and consequences if the waterbodies are left without any management approach. The broad objective of the study is to measure the macroeconomic benefits and trades-offs of CBFM approaches in the national economy, and examine the economic, social and environmental consequences of non-management of the fisheries resources. The specific objectives of the study are-.

- Updating the panel/regression analysis output tables of the earlier study on "Assessing Economy-wide Impacts of CBFM-2: A Case Study of Bangladesh" by analyzing extended data series (on catch monitoring and income-expenditure data) to be made available by the WorldFish Center.
- Analysis of Benchmark and Impact survey data, on (water body) communities selected for the latter survey, computerized data of which will be made available by the WorldFish Center.
- Upon reviewing existing literature on the subject, identify and/or develop a suitable macro model and undertake simulated projections under alternative scenarios with a view to assess contributions of CBFM intervention.

Annex B: Summary Tables from Monitoring Data

Annex B.1: Results on Household Consumption

Table B.1.1: Household Average Fish Production (kg)

	Flood Plain Beel	Open Beel					River	Closed Beel				
Season	Project	Project	Control	Project - Control	t-value	Sig.	Project	Project	Control	Project - Control	t-value	Sig.
2002, Q3	10.36	36.58	9.11	27.47	3.88	0.00	38.37	35.37	47.31	-11.95	-1.34	0.19
2002, Q4	38.55	16.30	11.54	4.76	1.03	0.31	26.21	21.59	46.40	-24.80	-2.60	0.02
2003, Q1	12.07	22.29	11.50	10.79	1.87	0.06	67.58	38.25	44.93	-6.68	-0.51	0.61
2003, Q2	15.41	31.62	18.46	13.16	1.76	0.08						
2003, Q3	25.86	68.73	29.56	39.18	2.35	0.02	59.82	58.91	79.37	-20.45	-0.73	0.48
2003, Q4	54.22	66.25	18.55	47.71	3.67	0.00	93.77	44.94	84.35	-39.41	-1.87	0.07
2004, Q1	20.73	44.92	6.16	38.76	3.58	0.00	58.44	33.00	66.47	-33.47	-2.17	0.04
2004, Q2	15.84	46.86	9.96	36.89	3.35	0.00						
2004, Q3	24.36	70.52	9.95	60.57	5.20	0.00	61.06	21.30	68.75	-47.46	-3.51	0.00
2004, Q4	16.31	33.87	13.69	20.19	3.10	0.00	62.78	20.63	30.73	-10.10	-1.94	0.06
2005, Q1	16.54	30.32	5.75	24.58	3.97	0.00	51.83	21.96	24.45	-2.49	-0.44	0.67
2005, Q2	5.69	11.90	6.05	5.85	1.84	0.07						
No. of households	133	140	58				17	13	12			

Note: Q_1 = Jan – Mar, Q_2 = Apr – Jun, Q_3 = Jul – Sep, Q_4 = Oct - Dec

* Some Households are missing

A value of significance (say) less than 0.05 implies that the difference between project and control is statistically significant at 5%.

Table B.1. 2: Household Total Consumption of Fish (kg)

	Flood Plain Beel	Open Beel					River	Closed Beel				
Season	Project	Project	Control	Project - Control	t-value	Sig.	Project	Project	Control	Project - Control	t-value	Sig.
2002, Q3	3.55	8.45	5.70	2.75	2.21	0.03	7.74	23.80	15.29	8.50	3.38	0.00
2002, Q4	9.18	4.79	8.25	-3.46	-3.06	0.00	8.24	16.33	17.66	-1.33	-0.26	0.80
2003, Q1	5.21	8.66	6.59	2.07	1.33	0.19	20.52	19.17	13.31	5.86	1.35	0.19
2003, Q2	5.23	10.65	9.81	0.83	0.39	0.69						
2003, Q3	7.61	14.88	10.37	4.51	1.86	0.06	19.24	33.16	25.06	8.10	1.04	0.31
2003, Q4	11.39	19.24	9.16	10.08	3.50	0.00	26.90	26.52	28.49	-1.97	-0.37	0.71
2004, Q1	6.33	17.02	2.98	14.04	5.59	0.00	19.88	19.73	21.16	-1.43	-0.21	0.83
2004, Q2	3.17	13.51	4.68	8.83	4.01	0.00						
2004, Q3	6.16	12.50	4.99	7.50	4.28	0.00	18.10	14.02	20.75	-6.74	-2.01	0.06
2004, Q4	3.05	7.92	6.43	1.50	1.27	0.21	15.41	13.87	16.41	-2.54	-0.98	0.34
2005, Q1	4.48*	11.20	2.12	9.08	5.69	0.00	14.64	14.95	12.22	2.73	0.73	0.47
2005, Q2	1.66	5.74	2.21	3.53	3.29	0.00						
No. of household	133	140	58				17	13	12			

Note: Q_1 = Jan – Mar, Q_2 = Apr – Jun, Q_3 = Jul – Sep, Q_4 = Oct - Dec

* Some Households are missing

A value of significance (say) less than 0.05 implies that the difference between project and control is statistically significant at 5%.

Table B.1.3: Household Kept Fish for Future Consumption (kg)

	Flood Plain Beel	Open Beel					River	Closed Beel				
Season	Project	Project	Control	Project - Control	t-value	Sig.	Project	Project	Control	Project - Control	t-value	Sig.
2002, Q3	0.71	0.72	0.06	0.65	1.57	0.12	0.24	0.00	1.33	-1.33	-1.77	0.09
2002, Q4	1.05	0.88	0.23	0.65	1.50	0.14	0.00	0.00	0.75	-0.75	-1.04	0.31
2003, Q1	0.94	0.99	0.41	0.58	1.81	0.07	4.57	0.17	0.25	-0.08	-0.26	0.80
2003, Q2	0.97	0.49	0.57	-0.09	-0.31	0.76						
2003, Q3	1.11	0.24	0.97	-0.74	-2.56	0.01	0.00	0.00	1.98	-1.98	-1.61	0.12
2003, Q4	2.96	0.78	0.55	0.23	0.55	0.59	1.03	1.15	2.34	-1.19	-0.70	0.49
2004, Q1	1.74	1.10	1.04	0.06	0.10	0.92	4.85	0.00	0.94	-0.94	-1.45	0.16
2004, Q2	0.52	1.70	1.07	0.63	0.41	0.68						
2004, Q3	1.25	12.50	4.99	0.24	1.12	0.26	0.96	0.60	5.19	-4.59	-1.69	0.10
2004, Q4	1.16	0.39	0.75	-0.36	-1.77	0.08	6.91	2.08	6.88	-4.80	-0.95	0.35
2005, Q1	0.89*	2.26*	0.72*	1.54	2.02	0.04	6.37	0.35	1.88	-1.53	-1.14	0.27
2005, Q2	0.08	0.71*	0.49	0.23	0.46	0.65						
No. of Households	133	140	58				17	13	12			

Note: Q_1 = Jan – Mar, Q_2 = Apr – Jun, Q_3 = Jul – Sep, Q_4 = Oct - Dec
* Some Households are missing
A value of significance (say) less than 0.05 implies that the difference between project and control is statistically significant at 5%.

Annex B.2: Results on Household Income/Expenditure

Table B.2.1: Total Food Expenditure of Household (Tk) for Flood Plain Beels

	Flood Plain Beel				
Season	Project	Control	Project - Control	t-value	Sig.
2003, Q1	6045.38	5120.71	924.67	2.65	0.01
2004, Q1	6002.28	4511.15	1491.13	4.44	0.00
2003, Q2	5932.05	5042.27	889.78	2.37	0.02
2004, Q2	6132.99	5696.04	436.95	1.56	0.12
2003, Q3	5913.74	5223.74	690.01	2.64	0.01
2004, Q3	6510.09	5162.92	1347.17	4.60	0.00
2003, Q4	6822.22	5857.40	964.81	3.42	0.00
2004, Q4	6586.91	6201.53	385.38	1.34	0.18
No. of Household	247	95			

Table B.2.2: Total Food Expenditure of Household (Tk) for Open Beels, Rivers & Closed Beels

	Open Beel					River	Closed Beel
Season	Project	Control	Project - Control	t-value	Sig.	Project	Project
2003, Q1	6418.87	10646.12	-4227.25	-2.96	0.00	9423.12	4592.07
2004, Q1	6155.94	6000.66	155.28	0.35	0.73	8285.56	4059.59
2003, Q2	5809.88	5738.34	71.54	0.16	0.87	8029.46	4529.37
2004, Q2	6066.88	7426.76	-1359.88	-2.95	0.00	7843.85	5018.69
2003, Q3	6379.97	8128.85	-1748.88	-2.52	0.01	7412.00	4413.25
2004, Q3	6165.63	7573.78	-1408.14	-2.90	0.00	7385.89	4436.70
2003, Q4	6204.61	7508.58	-1303.97	-2.92	0.00	7559.42	5010.42
2004, Q4	6891.85	7635.03	-743.18	-1.47	0.14	9089.18	5263.51
No. of Household	437	48				60	169

Table B.2.3: Total Expenditure on Non-food (Tk) for Flood Plain Beels

	Flood Plain Beel				
Season	Project	Control	Project - Control	t-value	Sig.
2003, Q1	4455.84	1722.15	2733.69	4.39	0.00
2004, Q1	4919.89	4350.24	569.65	0.68	0.49
2003, Q2	4548.78	1365.29	3183.48	3.62	0.00
2004, Q2	4656.27	2930.33	1725.94	1.68	0.09
2003, Q3	3841.32	1856.84	1984.47	2.51	0.01
2004, Q3	6006.71	3457.51	2549.20	2.21	0.03
2003, Q4	3547.83	1608.59	1939.24	3.86	0.00
2004, Q4	4581.31	2745.38	1835.94	2.19	0.03
No. of Household	247	95			

Table B.2.4: Total Expenditure on Non-food (Tk) for Open Beels, Rivers & Closed Beels

	Open Beel					River	Closed Beel
Season	Project	Control	Project - Control	t-value	Sig.	Project	Project
2003, Q1	3459.70	3506.20	-46.50	-0.04	0.96	3564.46	3669.87
2004, Q1	3938.25	2524.17	1414.09	1.64	0.10	4229.05	3276.19
2003, Q2	3805.45	2500.59	1304.86	1.68	0.09	2835.45	3245.29
2004, Q2	4356.02	1907.54	2448.48	1.98	0.05	3368.36	2518.17
2003, Q3	3672.29	2202.26	1470.03	1.90	0.06	3271.84	3574.65
2004, Q3	4525.41	1721.40	2804.01	3.63	0.00	2718.98	3446.54
2003, Q4	4189.11	1650.44	2538.67	2.28	0.02	3325.45	3552.53
2004, Q4	3792.30	1773.88	2018.42	2.47	0.01	3669.87	3024.03
No. of Household						60	169

Table B.2.5: Total Expenditure of Household (Tk) for Flood Plain Beels

	Flood Plain Beel				
Season	Project	Control	Project - Control	t-value	Sig.
2003, Q1	10501.23	6842.86	3658.37	4.54	0.00
2004, Q1	10922.17	8861.393	2060.78	2.00	0.05
2003, Q2	10480.83	6407.566	4073.26	3.76	0.00
2004, Q2	10789.25	8626.366	2162.89	1.92	0.06
2003, Q3	9755.062	7080.579	2674.48	2.99	0.00
2004, Q3	12516.8	8620.429	3896.37	3.05	0.00
2003, Q4	10370.05	7465.994	2904.05	4.30	0.00
2004, Q4	11168.23	8946.913	2221.31	2.24	0.03
No. of Household	247	95			

Table B.2.6: Total Expenditure of Household (Tk) for Open Beels, Rivers & Closed Beels

	Open Beel					River	Closed Beel
Season	Project	Control	Project - Control	t-value	Sig.	Project	Project
2003, Q1	9878.573	14152.32	-4273.75	-2.33	0.02	12987.58	8261.943
2004, Q1	10094.19	8524.824	1569.37	1.44	0.15	12514.61	7335.778
2003, Q2	9615.33	8238.926	1376.40	1.38	0.17	10748.43	7774.655
2004, Q2	10422.9	9334.302	1088.60	0.76	0.45	11169.3	7536.859
2003, Q3	10052.26	10331.1	-278.85	-0.25	0.80	10683.84	7987.9
2004, Q3	10691.04	9295.172	1395.87	1.37	0.17	10237.66	7883.238
2003, Q4	10393.71	9159.013	1234.70	0.94	0.35	10394.87	8562.951
2004, Q4	10684.15	9408.908	1275.24	1.14	0.25	12457.54	8287.534
No. of Household	437	48				60	169

Annex B.3: Results on Fish Production

Table B.3.1: Total Fish Production (kg.)

Type of WB	PS	December 2002 - May 2003	December 2003 - May 2004	December 2004 - May 2005	June 2003 - November 2003	June 2004 - November 2004	June 2005 - November 2005	2003	2004	2005
R	CBFM 2	74015.16	118315.44	126290.22	210709.68	265193.88	115770.06	284724.8	383509.3	242060.3
	Control	41630.28	54794.46	81593.46	70386.42	67217.76	28011.9	112016.7	122012.2	109605.4
OB	CBFM 2	311291.88	190568.28	77904.54	175632.48	295272.3	60993.9	486924.4	485840.6	138898.4
	Control	15608.34	3375.78	9139.74	10536.06	16600.26	5401.5	26144.4	19976.04	14541.24
CB	CBFM 2	23223.54	38376.18	27621.18	23554.86	58513.26	8338.74	46778.4	96889.44	35959.92
	Control	366.18	9932.4	2628.48	3508.86	9255.36		3875.04	19187.76	
FPB	CBFM 2	5060.04	7979.1	8886.9	19363.38	27141	49049.34	24423.42	35120.1	57936.24
	Control	514.62	1344.6	3557.22	3709.02	8658.06	5231.52	4223.64	10002.66	8788.74

Table B.3.2: Weighted Total Fish Production (kg.)

	Project	Control	Difference	DD
2003	311087.4	41497.9	269589.6	
2004	339423.6	46682.4	292741.2	23151.6
2005	131945.7	49471.2*	82474.5	-210266.7

1 Weighted average without CB

Table B.3.3: Average Fish Production of Gill-Net per man-hour (kg.)

Types of WB		River				Flood Plain Beel				Open Beel				Closed Beel			
Time Period	Project Status	Mean	CBFM 2 - Control			Mean	CBFM 2 - Control			Mean	CBFM 2 - Control			Mean	CBFM 2 - Control		
			Value	t-stat	Sig.		Value	t-stat	Sig.		Value	t-stat	Sig.		Value	t-stat	Sig.
December 2002 - May 2003	CBFM 2	0.45	0.02	0.28	0.78	0.58	0.27	1.21	0.25	0.35	-0.15	-2.11	0.04	0.41	0.22	1.40	0.16
	Control	0.43				0.31				0.50				0.19			
December 2003 - May 2004	CBFM 2	0.47	0.00	0.04	0.96	0.70	0.59	2.33	0.02	0.79	0.69	1.65	0.10	0.91	0.43	3.24	0.00
	Control	0.47				0.11				0.11				0.48			
December 2004 - May 2005	CBFM 2	0.46	0.06	1.26	0.21	0.87	0.47	-0.32	0.75	0.61	0.36	2.11	0.04	1.12	0.88	1.65	0.10
	Control	0.41				0.41				0.26				0.24			
June 2003 - November 2003	CBFM 2	0.49	0.07	1.19	0.23	0.39	-0.04	1.82	0.09	0.44	0.15	1.15	0.25	0.82	0.57	1.41	0.16
	Control	0.42				0.43				0.29				0.25			
June 2004 - November 2004	CBFM 2	0.41	0.00	0.04	0.97	0.61	0.38	1.50	0.15	0.61	0.48	0.70	0.48	0.72	0.51	1.19	0.24
	Control	0.41				0.23				0.14				0.20			
June 2005 - November 2005	CBFM 2	0.48	0.16	2.91	0.00	0.96	0.69	3.47	0.00	0.45	0.28	4.32	0.00	0.85	0.71	3.60	0.00
	Control	0.32				0.27				0.16				0.13			

Table B.3.4: Weighted Average fish production of Gill Net per man-hour (kg.)

Year	Project	Control	Difference	DD
2003	0.913820	0.705975	0.207844	
2004	1.319327	0.544723	0.774604	0.566196
2005	1.288627	0.514887	0.773741	-0.000863

Annex C: Summary Tables on Comparison between Benchmark and Impact Survey

Table C.1: Average Annual Income by Disaggregated Sources (Figures in Taka for respective years)

Income Source	Benchmark			Impact		
	Beneficiary	Non-beneficiary	All	Beneficiary	Non-beneficiary	All
Total Agriculture	**4615**	**10219**	**9098**	**10340**	**20491**	**18461**
Agricultural product	457	1653	1413	2219	5334	4711
Agriculture	4157	8567	7685	8122	15157	13750
Total Fishing	**3075**	**1702**	**1976**	**17851**	**5684**	**8117**
Fish labor	357	217	245	1164	258	439
Fish trade	0	0	0	27	91	78
Fish and Fish related trading	965	657	719	2787	780	1181
Fish fry selling	34	33	33	111	65	75
Fish pond/culture	394	512	488	490	972	876
Drying/processing fish	71	48	52	349	28	93
Direct Fishing	1255	236	440	12922	3490	5376
Total Trade	**1909**	**3709**	**3349**	**3502**	**6581**	**5965**
Trade & handicrafts	1191	1709	1605	2023	2234	2192
Business/petty trade/handicrafts/cart	718	2000	1744	1479	4348	3774
Total Semi skilled labor	**204**	**177**	**182**	**216**	**260**	**251**
Semi-skilled labor (daily)	135	76	88	162	128	134
Semi-skilled labor (annual)	1	2	2	30	36	35
Making and repairing of fish net/poultry rearing boxes	68	99	92	24	97	82
Total Profession/ service	**379**	**2885**	**2384**	**1665**	**4951**	**4294**
Low paid daily services/profession	0	12	10	0	66	53
Service/profession(annual)	379	2873	2374	1665	4886	4241
Total Remittance	**773**	**2223**	**1933**	**1865**	**4080**	**3637**
Remittance	0	0	0	225	412	374
Internal remittance	773	2223	1933	1640	3669	3263
Total Other income	**4203**	**5518**	**5255**	**5915**	**7019**	**6798**
Other labor	3562	5236	4901	5282	6580	6321
Other income(domestic service, beggar, other sources)	641	282	354	633	439	478
Self employment	634	1135	1035	2109	2085	2090
Entrepreneur income	84	3	20	29	101	87
Livestock	773	826	815	1131	1243	1221
Dowry received	47	60	57	134	153	149
Samiti income(accrued to individual)	3	9	8	7	37	31
Earning from lending	5	0	1	0	28	23
Land rented out	199	700	600	297	1436	1209
Equipment rental	58	419	347	385	797	714
Total	**16959**	**29586**	**27061**	**45444**	**54948**	**53047**
% change(impact over benchmark)				167.96	85.72	96.03

Table C.2: Percentage Distribution of Annual Income by Sources

	Benchmark			Impact		
Income Source	Beneficiary	Non-beneficiary	All	Beneficiary	non-beneficiary	All
Total Agriculture	**27.21**	**34.54**	**33.62**	**22.75**	**37.29**	**34.80**
Agricultural product	2.70	5.59	5.22	4.88	9.71	8.88
Agriculture	24.51	28.96	28.40	17.87	27.58	25.92
Total Fishing	**18.13**	**5.75**	**7.30**	**39.28**	**10.34**	**15.30**
Fish labor	2.10	0.73	0.90	2.56	0.47	0.83
Fish trade	0	0	0	0.06	0.17	0.15
Fish and Fish related trading	5.69	2.22	2.66	6.13	1.42	2.23
Fish fry selling	0.20	0.11	0.12	0.25	0.12	0.14
Fish pond/culture	2.32	1.73	1.80	1.08	1.77	1.65
Drying/processing fish	0.42	0.16	0.19	0.77	0.05	0.17
Direct Fishing	7.40	0.80	1.62	28.44	6.35	10.13
Total Trade	**11.26**	**12.54**	**12.38**	**7.71**	**11.98**	**11.25**
Trade & handicrafts	7.03	5.78	5.93	4.45	4.07	4.13
Business/petty trade/handicrafts/cart	4.23	6.76	6.44	3.25	7.91	7.11
Total Semi skilled labor	**1.20**	**0.60**	**0.67**	**0.47**	**0.47**	**0.47**
Semi-skilled labor(daily)	0.80	0.26	0.33	0.36	0.23	0.25
Semi-skilled labor(annual)	0.01	0.01	0.01	0.07	0.07	0.07
Making and repairing of fish net/poultry rearing boxes	0.40	0.33	0.34	0.05	0.18	0.15
Total Profession/service	**2.23**	**9.75**	**8.81**	**3.66**	**9.01**	**8.09**
Low paid daily service/profession	0.00	0.04	0.04	0.00	0.12	0.10
Service(profession)	2.23	9.71	8.77	3.66	8.89	8.00
Total Remittance	**4.56**	**7.52**	**7.14**	**4.10**	**7.43**	**6.86**
Remittance	0.00	0.00	0.00	0.50	0.75	0.71
Internal remittance	4.56	7.52	7.14	3.61	6.68	6.15
Total Other income	**24.78**	**18.65**	**19.42**	**13.02**	**12.77**	**12.82**
Other labor	21.00	17.70	18.11	11.62	11.98	11.91
Other income (domestic service, beggar, other sources)	3.78	0.95	1.31	1.39	0.80	0.90
Self employment	3.74	3.84	3.83	4.64	3.79	3.94
Entrepreneur income	0.49	0.01	0.07	0.06	0.18	0.16
Livestock	4.56	2.79	3.01	2.49	2.26	2.30
Dowry received	0.28	0.20	0.21	0.29	0.28	0.28
Samiti income (accrued to individuals)	0.02	0.03	0.03	0.01	0.07	0.06
Earning from lending	0.03	0.00	0.00	0.00	0.05	0.04
Land rented out	1.17	2.37	2.22	0.65	2.61	2.28
Equipment rental	0.34	1.42	1.28	0.85	1.45	1.35

Table C.3: Percentage of Households Reporting Positive Income by Sources

Income source	Benchmark			Impact		
	Beneficiary	Non-beneficiary	All	Beneficiary	Non-beneficiary	All
Agriculture	66.67	75.56	73.78	69.59	76.35	75.00
Agricultural product	9.91	19.03	17.21	26.80	31.59	30.63
Total Agriculture	**64.64**	**74.94**	**72.88**	**70.27**	**78.32**	**76.71**
Fishing	11.04	3.43	4.95	79.73	26.01	36.76
Fish labor	14.19	5.01	6.85	25.90	4.56	8.83
Fish trade	0.00	0.00	0.00	0.23	0.28	0.27
Fish and Fish related trading	9.91	4.90	5.90	11.71	3.83	5.41
Fish fry selling	0.90	0.51	0.59	0.90	0.39	0.50
Fish pond/culture	4.28	5.57	5.32	8.11	8.33	8.29
Drying/processing fish	0.45	0.39	0.41	1.58	0.39	0.63
Total Fish	**34.46**	**16.39**	**20.00**	**38.51**	**15.60**	**20.18**
Self employment	6.76	8.84	8.42	14.86	12.84	13.24
Trade & handicrafts	12.61	13.68	13.47	13.51	14.86	14.59
Business/petty trade/handicrafts/cart	4.50	9.18	8.24	10.14	13.06	12.48
Total Trade	**17.12**	**22.13**	**21.13**	**22.30**	**26.58**	**25.72**
Semi-skilled labor	0.23	0.34	0.32	0.23	0.68	0.59
Semi-skilled labor	0.45	0.51	0.50	0.68	0.84	0.81
Net making/repairing/poultry rearing boxes	0.23	0.23	0.23	2.48	0.90	1.22
Total Semi skilled labor	**0.90**	**1.07**	**1.04**	**3.38**	**2.42**	**2.61**
Low paid daily service/profession	0.00	0.17	0.14	0.00	0.51	0.41
Service(profession)	3.15	8.67	7.57	7.88	13.12	12.07
Total Profession	**3.15**	**8.78**	**7.66**	**7.88**	**13.57**	**12.43**
Entrepreneur income	0.45	0.06	0.14	0.45	0.45	0.45
Livestock	51.13	54.67	53.96	58.33	58.73	58.65
Remittance	0.00	0.00	0.00	0.23	0.23	0.23
Internal remittance	3.15	6.59	5.90	6.53	9.12	8.60
Total Remittance	**3.15**	**6.59**	**5.90**	**6.76**	**9.35**	**8.83**
Dowry received	0.68	0.23	0.32	0.90	0.90	0.90
Samiti income	0.23	0.23	0.23	0.23	0.23	0.23
Lend financing	0.23	0.00	0.05	0.00	0.34	0.27
Land rented out	4.05	7.43	6.76	4.73	11.77	10.36
Equipment rental	2.03	5.86	5.09	4.95	6.81	6.44
Other labor	57.66	53.49	54.32	59.01	52.42	53.74
Other income(domestic service, beggar, other sources)	6.76	4.45	4.91	6.31	6.31	6.31
Total Other income	**59.01**	**54.95**	**55.77**	**60.36**	**54.45**	**55.63**

Table C.4: Percentage Distribution of Total Annual Expenditure by Sources

	Benchmark			Impact		
	Beneficiary	Non-beneficiary	All	Beneficiary	Non-beneficiary	All
Food	46.25	42.92	45.61	34.42	31.40	33.55
Clothing	6.66	6.85	6.70	5.75	6.15	5.86
House repair/building	6.99	6.99	6.99	7.86	3.65	6.65
Education	3.46	3.81	3.52	4.00	3.60	3.88
Health	6.46	7.23	6.61	6.66	6.12	6.50
Fuel	2.35	2.25	2.33	2.44	2.03	2.33
Travel	3.12	3.05	3.11	2.28	2.20	2.26
Loan repayment	5.99	6.00	5.99	8.01	9.53	8.45
Land	4.96	4.86	4.94	9.45	8.37	9.14
Livestock	1.33	1.76	1.41	2.29	3.18	2.55
Furniture and equipment	0.88	0.57	0.82	1.19	1.00	1.14
Festivals	7.11	7.98	7.28	8.84	7.91	8.57
Fish culture	0.07	0.02	0.06	0.14	0.08	0.12
Boat	0.04	n/a	0.03	0.00	0.01	0.00
Ornaments/cosmetics	0.10	n/a	0.08	1.18	0.78	1.07
Others	4.22	5.71	4.50	5.48	14.00	7.93
Total	100.00	100.00	100.00	100.00	100.00	100.00

Table C.5: Percentage of Households Reporting Positive Expenditure

Sources	Benchmark			Impact		
	Beneficiary	Non- beneficiary	All	Beneficiary	Non-beneficiary	All
Food	100	99.72	99.77	100	100	100
Clothing	99.77	99.38	99.46	99.32	98.93	99.01
Housing (repair + building+ rent)	59.68	49.07	51.19	53.15	47.10	48.31
Education	50.23	59.15	57.37	57.66	66.03	64.35
Health	97.30	97.13	97.16	98.20	97.58	97.70
Fuel	97.97	96.56	96.85	99.32	98.70	98.83
Travel	81.08	85.30	84.45	91.44	90.93	91.03
Loan repayment	26.80	31.15	30.28	46.62	38.25	39.93
Savings	20.05	18.08	18.48	28.60	20.85	22.40
Land(purchase, tax, mortgage)	10.14	9.13	9.33	23.87	21.92	22.31
Livestock	12.16	13.86	13.52	19.37	25.13	23.97
Furniture & equipment	15.99	16.06	16.04	22.75	21.75	21.95
Festival	95.27	96.51	96.26	96.62	94.25	94.73
Fish	1.13	0.34	0.50	1.13	2.70	2.39
Bribe (payment)	0.45	0.11	0.18	0.00	0.28	0.23
Boat	0.23	0.11	0.14	0.23	0.11	0.14
Ornament	0.23	0.11	0.14	32.21	39.27	37.85
Other	48.42	58.14	56.20	66.67	68.17	67.87

Table C.6: Ownership of Assets

	Benchmark			Impact		
Asset	Beneficiary	Non-beneficiary	All	Beneficiary	Non-beneficiary	All
Number of dwelling	1.30	1.96	1.83	1.45	1.46	1.45
Area of dwelling (sq. feet)	314.55	371.56	360.16	367.76	439.43	425.09
Number of bed	1.75	2.00	1.95	2.17	2.36	2.32
No of bicycle	0.24	0.39	0.36	0.32	0.46	0.43
No of rickshaw/van	0.05	0.07	0.06	0.10	0.10	0.10
No of cattle/ buffalo	0.94	1.26	1.20	1.11	1.50	1.42
No of goat/ sheep	0.40	0.55	0.52	0.66	0.61	0.62

Table C.7: Percentage of Households Reporting Ownership of Assets

Source	Benchmark (before)			Impact (after)		
	Beneficiary	Non-beneficiary	All	Beneficiary	Non-beneficiary	All
Number of dwelling	99.55	99.21	99.28	99.32	99.55	99.50
Area of dwelling	99.77	98.25	98.56	99.55	99.32	99.37
Number of bed	90.54	91.27	91.13	96.40	96.96	96.85
No of TV	2.93	7.71	6.76	9.23	14.25	13.24
No of radio	16.22	21.57	20.50	22.75	25.17	24.68
No of bicycle	21.85	34.91	32.30	27.93	40.15	37.70
No of rickshaw/van	4.73	6.36	6.04	8.56	9.52	9.32
No of cattle/ buffalo	43.92	51.86	50.27	50.23	59.57	57.70
No of goat/ sheep	18.92	25.68	24.32	29.28	27.76	28.06

Table C.8: Average Size of Land Ownership

Source	Benchmark			Impact		
	Beneficiary	Non-beneficiary	All	Beneficiary	Non-beneficiary	All
1) Own homestead land	6.75	10.46	9.72	7.71	10.12	9.63
2) Homestead land owned by someone else	0.88	1.08	1.04	1.54	1.20	1.27
3) Own pond or ditch	1.24	4.02	3.46	2.14	3.98	3.61
4) Land owned and cultivated by the household	26.47	76.51	66.50	25.34	71.82	62.52
5) Land cultivated last year but owned by others	29.05	34.94	33.77	35.43	39.10	38.36
6) Land owned but cultivated last year by others	4.49	15.98	13.68	6.09	18.63	16.12
7) Khas land	2.34	1.26	1.48	2.84	1.89	2.08
8) Land owned but mortgaged out	4.46	11.29	9.93	5.26	11.11	9.94
9) Own non-cultivated land	0.67	3.29	2.77	11.79	23.82	21.84
Total own land (1+3+4+6+8+9)	44.08	121.55	106.06	47.65	118.51	104.34
% Change in total own land				8.11	-2.50	-1.62

Table C.9: Percentage of Households Reporting Ownership of Land

Source	Benchmark			Impact		
	beneficiary	non-beneficiary	All	beneficiary	non-beneficiary	All
Own homestead land	84.68	87.05	86.58	82.21	86.88	85.95
Homestead land owned by someone else	14.19	12.61	12.93	20.50	14.98	16.08
Own pond or ditch	12.61	22.69	20.68	14.19	26.18	23.78
Land owned and cultivated by the household	45.27	57.15	54.77	41.89	54.50	51.98
Land cultivated last year but owned by others	42.57	44.03	43.74	52.70	48.87	49.64
Land owned but cultivated last year by others	4.73	11.09	9.82	6.31	13.06	11.71
khas land	3.83	2.08	2.43	11.71	5.01	6.35
Land owned but mortgaged out	9.68	18.13	16.44	12.16	18.75	17.43
Own non-cultivated land	3.83	6.64	6.08	100.00	99.83	99.86

Table C.10: Average Years of Schooling

Education Level	Benchmark			Impact		
	Beneficiary	Non-beneficiary	All	Beneficiary	Non-beneficiary	All
	Mean	Mean	Mean	Mean	Mean	Mean
Education of children (age 5 to 10 years)	1.38	1.44	1.40	1.43	1.37	1.41
Education of adolescents (age 11 to 15)	4.35	4.73	4.45	4.84	4.96	4.87
Adult education (age 16 and more)	2.84	2.93	2.86	3.44	3.44	3.44

Table C.11: Distribution of Total Fishing Income

Sources	Benchmark			Impact		
	beneficiary	non-beneficiary	All	beneficiary	non-beneficiary	All
Fish labor	11.60	12.73	12.38	6.52	4.53	5.41
Fish trade	0	0	0	0.15	1.59	0.96
Fisjh and Fish related trading	31.38	38.61	36.36	15.61	13.72	14.55
Fish fry selling	1.09	1.92	1.66	0.62	1.15	0.92
Fish pond/culture	12.80	30.07	24.70	2.74	17.10	10.79
Drying/processing fish	2.31	2.81	2.65	1.96	0.50	1.14
Direct Fishing	40.82	13.86	22.25	72.39	61.40	66.23
Total Fishing income	**3075**	**1702**	**1976**	**17851**	**5684**	**8117**
% change in total fishing income				480	234	311

Table C.12: Changes in Expenditure in Bangladesh as a result of an increase in catch of capture fish – Results of Simulation with National SAM under different scenarios

Household Groups	**Percentage change in per capita expenditure**				
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Landless	8.84	4.45	5.58	5.66	16.05
Marginal Farmer	8.64	4.35	5.45	5.53	15.68
Small farmer	9.38	4.72	5.92	6.01	17.03
Large Farmer	11.15	5.62	7.04	7.14	20.25
Non Agri	8.68	4.37	5.48	5.56	15.75
illiterate	8.44	4.25	5.33	5.40	15.31
Low educated	8.67	4.36	5.47	5.55	15.73
Medium educated	8.39	4.22	5.30	5.37	15.23
High educated	8.78	4.42	5.54	5.62	15.93
All	**8.91**	**4.49**	**5.62**	**5.71**	**16.17**

Annex D: Statistical Tables and Estimation Method

Annex D.1: Trends in Inland Fishery

Table D.1.1: Quantity of Fresh Fish Caught By Source (Hundred Thousand Metric Tons)

Year	Inland		Marine	Total	Share of Capture in Total (%)
	Capture	Culture			
1984-85	4.63	1.23	1.88	7.74	59.82
1985-86	4.42	1.45	2.07	7.94	55.67
1986-87	4.31	1.66	2.18	8.15	52.88
1987-88	4.23	1.76	2.28	8.27	51.15
1988-89	4.24	1.84	2.33	8.41	50.42
1989-90	2.24	1.93	2.39	6.56	34.15
1990-91	4.43	2.11	2.42	8.96	49.44
1991-92	4.89	2.27	2.46	9.62	50.83
1992-93	5.33	2.38	2.50	10.21	52.20
1993-94	5.74	2.64	2.53	10.91	52.61
1994-95	5.92	3.16	2.65	11.73	50.47
1995-96	6.09	3.79	2.70	12.58	48.41
1996-97	6.00	4.86	2.75	13.61	44.09
1997-98	6.16	5.75	3.10	15.01	41.04
1998-99	6.49	5.94	3.34	15.77	41.15
1999-00	6.70	6.57	3.79	17.06	39.27
2000-01	6.89	7.13	4.00	18.02	38.24
2001-02	6.89	7.87	4.32	19.08	36.11
2002-03	7.09	8.57	4.55	20.21	35.08
2003-04	7.32	9.15	4.75	21.22	34.50
2004-05	8.59	8.82	5.27	22.68	37.87

Source: Statistical Yearbook of Bangladesh, BBS, various issues

Table D.1.2: Share of HYV Aman in Total Aman Acreage

Year	Aman HYV Acreage ('000 Acres)	Total Aman Acreage ('000 Acres)	Share of HYV Aman (%)	Total Fertilizer Use ('000 Metric Tons)
1980-81	2376	14918	15.93	823.33
1981-82	2361	14854	15.89	771.38
1982-83	2653	14812	17.91	871.57
1983-84	2329	14845	15.69	1033.02
1984-85	2669	14112	18.91	1260.22
1985-86	2907	14876	19.54	1155.99
1986-87	3085	14958	20.62	1320.94
1987-88	2958	13816	21.41	1515.19
1988-89	3346	12606	26.54	1709.04
1989-90	4354	14095	30.89	2043.18
1990-91	4857	14273	34.03	2107.54
1991-92	5210	14068	37.03	2287.43
1992-93	5759	14441	39.88	2316.18
1993-94	5584	14209	39.30	2217.68
1994-95	5304	13824	38.37	2640.62
1995-96	5606	13953	40.18	3022.69
1996-97	6107	14339	42.59	3036.56
1997-98	6294	14353	43.85	2618.73
1998-99	6087	12762	47.70	2824.92
1999-00	6822	14098	48.39	2826.42
2000-01	6911	14110	48.98	-
2001-02	7079	13955	50.73	-
2002-03	7261	14041	51.71	-

Source: Statistical Yearbook of Bangladesh, BBS, various issues

Annex D.2: Methodology

Annex D.2.1: Generating the Variables for Regression

Price of capture fish: This is calculated from the monitoring data on consumption. First the fish type is determined on the basis of fish source where for example if for a particular fish more than 70% of the observations have source, *bought wild*, then it is identified as a capture fish, if more than 70% of the observations have source, *bought cultured* then it is identified as a cultured fish other wise the fish type is identified as mixed. Then the price of capture fish per kilogram in a month for a water body is calculated by taking the ratio of total cost and quantity bought.

Price of non-fish food: This is also calculated from the monitoring data on consumption. First the price of each type of food item in a given month in a water body is calculated by taking the ratio of average expenditure and quantity bought of that item on a day of the month for a water body. Then weighted average of these prices are calculated by using the share of average expenditure on the item in total expenditure on a day in a month in a particular as weight for each water body.

Time: The survey was carried out between July 2002 and July 2005. In between there were 37 months. Accordingly the first month is assigned the value 1 and the last one is assigned 37 with an increase of 1 for each successive month.

Area of water body: The mean area of water body is taken from the data file area of water body.

Active gears per hectare: This is calculated from the gear survey. First the number of active gears is classified into three types: net, line and other. For each survey date total of each type of gear in use is calculated then the mean number of active gears per category on a day in a month in a water body is calculated and then they are summed across categories to get the mean number of active gears on a day in a month in a water body. It is then divided by the size of the water body to get the average number of active gears per hectare on a day in a month in a water body.

Quantity of capture fish per day: This is calculated from the catch monitoring data. First the fish were classified into capture, cultured and mixed by using the information mentioned above while discussing the price of capture fish. Total catch reported under each type is divided by the fishing time for the current capture and multiplied by the total of fishing time (sum of time elapsed and expected fishing time for the remainder of the day) and then the mean of this division is calculated for each day. This is then summed for all the survey days in a month and divided by the number of survey days in that month. The figure arrived at is then divided by the mean number of observations per day and multiplied by the average number of active gears on a day in a month in a water body to get the average daily capture in a month for a particular water body.

Annex D.2.2: Panel Creation

For the analysis on the monitoring data on consumption and income/expenditure, individual panels are created where the time dimension is quarter of a year. So only the households that have at least one observation in each quarter are selected for the panel. But the panel thus created on consumption data does not contain any observation from River and Closed Beel and so a reduced panel on consumption data dropping the second quarter is created for these two types of water bodies, as the number of observations in the second quarter is very low for these two types of water bodies. Since Income/Expenditure data were collected from December, 2002 and also the number of observations on the first two quarters of 2005 is very low, a reduced panel only considering data from 2003 and 2004 is created. The following tables give the size of the panels.

Table D.2.2.1: Panel on Consumption data with all quarters

Water body / Project Status	Number of Households
Flood Plane Beel	
Project	133
Control	0
Open Beel	
Project	140
Control	58

Table D.2.2.2: Panel on Consumption data dropping 2nd quarter

Water body / Project Status	Number of Households
Closed Beel	
Project	13
Control	12
River	
Project	17
Control	0

Table D.2.2.3: Panel on Income/Expenditure data with all quarters from 2003 and 2004

Water body / Project Status	Number of Households
Flood Plane Beel	
Project	247
Control	95
Open Beel	
Project	437
Control	48
Closed Beel	
Project	169
Control	0
River	
Project	60
Control	0

Annex D.2.3: Data Gaps

Data was collected only on eight rivers of which two are control sites. Unfortunately, for some of these rivers not a single observation is there for some quarters like the first quarter of 2005 does not contain any observation on Meghna River. As a result if a panel is created for only those households that have information in all quarters, households belonging to Meghna River, which is a control water body, will drop out. This is also true for the other control river, which is left out in many quarters. Similarly, two other control sites, Sheikhati Beel, a flood plane beel and Doriar Beel, a closed beel, are dropped from such panel as no information about them are available respectively on the first and the second quarters of 2005.

Table D.2.3.1: Number of months in different quarters which do not have information in the consumption monitoring data in river type of water bodies

	CBFM Waterbody						Control Waterbody	
	Titas Nodi (ka)	Titas Nodi (Gokon-Goshaipur) JR	Moisherkandi Boronpur Nodi JNFMP	Ubdakhali nodi Jalmahal and Hogla Beel JR+B	Pagla Nodi (Titas Nodi to MEGHNARIVER river)	Ghor Bhanga Nadi Jalmohal part 1	Meghna river (Bhairab bazar bridge to Durgarampur)	Gumai River and Mandaura
July-Sep of 2002	1	1	1	2	3	1	2	2
Oct-dec of 2002	1	1	2	1	3	2	0	1
Jan-March of 2003	1	1	0	0	3	1	0	0
April-June of 2003	0	0	0	0	3	0	0	0
July-Sep of 2003	0	0	0	0	3	0	0	0
Oct-Dec of 2003	0	0	0	0	3	0	0	0
Jan-March of 2004	0	0	0	3	3	0	0	3
April-June of 2004	0	0	2	3	3	2	0	3
July-Sep of 2004	1	1	1	3	3	1	1	3
Oct-Dec of 2004	2	3	2	3	3	2	1	3
Jan-March of 2005	3	1	1	3	3	1	3	3
April-June of 2005	3	2	2	3	3	2	1	3
Total	13	11	12	22	37	13	9	22

Table D.2.3.2: Number of months in different quarters which do not have information in the consumption monitoring data in closed beel type of water bodies

	CBFM Waterbody			Control Waterbody
	Hamil Beel JB (CBFM-1)	Saralar Beel JB	MEGHNA-RIVER Beel JB	Doriar Beel
July-Sep of 2002	1	1	1	1
Oct-dec of 2002	1	1	1	1
Jan-March of 2003	1	0	1	1
April-June of 2003	0	0	0	0
July-Sep of 2003	0	0	0	0
Oct-Dec of 2003	0	0	0	0
Jan-March of 2004	0	0	0	0
April-June of 2004	0	1	1	1
July-Sep of 2004	1	1	1	1
Oct-Dec of 2004	2	2	2	2
Jan-March of 2005	1	2	1	2
April-June of 2005	2	3	3	3
July-Sep of 2005	1	1	1	1
Total	10	12	12	13

Table D.2.3.3: Number of months in different quarters which do not have information in the consumption monitoring data in flood plain type of water bodies

	CBFM Waterbody				Control Waterbody
	Goakhola-Hatiara	Shuluar Beel	Kathuria Beel	Maliate Beel	Sheikhati Beel
July-Sep of 2002	1	2	1	1	1
Oct-dec of 2002	1	0	1	1	1
Jan-March of 2003	1	0	1	1	1
April-June of 2003	0	0	0	0	0
July-Sep of 2003	0	0	0	0	0
Oct-Dec of 2003	0	0	0	0	0
Jan-March of 2004	0	0	0	0	0
April-June of 2004	0	0	0	0	0
July-Sep of 2004	0	0	0	0	0
Oct-Dec of 2004	1	2	1	1	1
Jan-March of 2005	3	1	3	3	3
April-June of 2005	1	2	1	1	1
July-Sep of 2005	1	0	1	1	1
Total	9	7	9	9	9

Also in income/expenditure data observations on some water bodies are missing in some quarters and as a result a comprehensive panel covering all the quarters cannot be created.

Table D.2.3.4: Number of months in different quarters which do not have information in the income/expenditure monitoring data in river type of water bodies

	CBFM Waterbodies						Control Waterbody	
	Titas Nodi (ka)	Titas Nodi (Gokon-Goshaipur) JR	Moisherkandi Boronpur Nodi JNFMP	Ubdakhali nodi Jalmahal and Hogla Beel JR+B	Pagla Nodi (Titas Nodi to MEGHNARIVER river)	Ghor Bhanga Nadi Jalmohal part 1	Meghna river (Bhairab bazar bridge to Durgarampur)	Gumai River and Mandaura
Oct-dec of 2002	0	0	0	1	1	0	0	1
Jan-March of 2003	0	0	0	0	3	0	0	3
April-June of 2003	0	0	0	0	3	0	0	3
July-Sep of 2003	0	0	0	0	3	0	0	3
Oct-Dec of 2003	0	0	0	0	3	0	0	3
Jan-March of 2004	0	0	0	3	3	0	0	3
April-June of 2004	0	1	0	3	3	0	0	3
July-Sep of 2004	0	0	0	3	3	0	0	3
Oct-Dec of 2004	0	1	0	3	3	0	1	0
Jan-March of 2005	3	3	0	3	3	0	2	0
April-June of 2005	3	3	1	3	3	1	0	3
July-Sep of 2005	1	1	1	1	1	1	0	1
Total	7	9	2	20	32	2	3	26

Table D.2.3.5: Number of months in different quarters which do not have information in the income/expenditure monitoring data in closed beel type of water bodies

	CBFM Waterbodies			Control Waterbody
	Hamil Beel JB (CBFM-1)	Saralar Beel JB	MEGHNARIVER Beel JB	Doriar Beel
Oct-dec of 2002	0	0	1	0
Jan-March of 2003	0	0	0	1
April-June of 2003	0	0	0	0
July-Sep of 2003	0	0	0	0
Oct-Dec of 2003	0	0	0	0
Jan-March of 2004	0	0	0	0
April-June of 2004	0	0	0	0
July-Sep of 2004	1	0	0	0
Oct-Dec of 2004	3	0	0	1
Jan-March of 2005	3	2	2	2
April-June of 2005	3	3	3	3
July-Sep of 2005	1	1	1	1
Total	11	6	7	8

Annex D.3: Changes in the relative price of fish to non-fish food items (Based on the study by Madan *et al*.)

Price Elasticity of demand for fish = 0.6%
Expenditure elasticity of demand for capture fish = 1.2%
Elasticity of supply of capture fish = 0.47%
Percentage increase in income = 6.2%
Percentage increase price of non-fish items = 3.1%
Percentage change in the price of fish = 4.368%
Assuming there is no excess demand, the ratio of percentage change in the price of capture fish to non-fish = 4.386%/3.1% = 1.41%.