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# Sustainable Rural Livelihoods and Co-management Intervention: The Case of Mokosh Beel, Gazipur, Bangladesh

Umme Kulsum Ferdousi

## *Abstract*

*Co-management is a tool for promoting the sustainable management of inland fisheries resources whereby water bodies are collaboratively managed by local communities and government entities. This study investigated inland aquatic resource management and its interdependence with the livelihood patterns of beneficiaries involved in the co-management system in Mokosh Beel of Bangladesh. Mokosh Beel has been under ecological pressure from both fishing and the presence of highly polluting industries in the surrounding area. Data were collected through focus group discussions and semi-structured interviews. In this study, I investigated the institutional arrangements of co-management in the study area. Resource management organizations (RMOs), resource user groups (RUGs), and federations of resource user groups (FRUGs) have participated actively in the co-management system and worked together with local fishers and with other relevant organizations concerned with different national issues. I also assessed the resource users' awareness and knowledge of co-management practices. The results reveal that most respondents were interested in engaging in increasing fish production and alternative income-generating activities. Results further show that the non-fisher group was actively engaged in co-management decision-making activities and plan preparation, whereas fishers were not, and that both fishers and non-fishers were engaged in the implementation stage. I identified about 20 direct and indirect benefits that improved the livelihoods of respondents. Respondents in the study area also expressed a great desire to continue this co-management practice, although they feared inconsistency in co-management activities due to improper supervision after termination of the project. I argue that the sustainability of the co-management approach depends on the active participation of all members of co-management organizations. At the same time, the government should take measures, including direct interventions, to stop pollution by the industries.*

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Assistant Director, Department of Fisheries, Matshya Bhaban, Dhaka, Bangladesh.

## Introduction

Co-management is a tool for the sustainable management of inland fisheries resources whereby water bodies are operated and managed by local communities in an effort to ensure equal rights and access to and sustainable use and management of their resources. The success of co-management depends on the motivation and active participation of community members (Thompson and Colavito 2007).

Bangladesh is endowed with extensive floodplains and wetlands, which are home to hundreds of species of aquatic plants, birds, and other wildlife and are rich in fisheries. These wetlands provide critical habitat for millions of migratory birds and are an important source of livelihood and nutrition for millions of Bangladesh's rural poor, especially for fishers, who are primarily dependent on these wetlands for their economic well-being. The historical contribution of inland fisheries to the livelihoods of rural people is reflected in the traditional popular saying, "Fish and rice make a Bengali." About 1.28 million rural households nationwide undertake fishing to help meet their subsistence needs (DoF 2011). The wetlands also help to prevent floods, protect shorelines, cleanse polluted waters, and recharge groundwater aquifers. This is why wetlands are known as the "kidneys of the landscape" (Mitch and Gosselink 1993). Wetlands have also been called a "biological supermarket" because they support an extensive food web and a wide range of biodiversity (Mitch and Gosselink 1993). Over the years, fisheries in *haors* (floodplain areas that are inundated during the monsoon season) and *beels* (deeper depressions where water remains throughout the year) have been allowed to follow an open-access regime, without consistent, well-organized, or effective management policies for preserving aquatic biodiversity (Ahmed and Hossain 1990).

There is increasing evidence that inland aquatic resources are drastically declining in both quantity and quality, and there is a severe loss of aquatic biodiversity due to over-exploitation of aquatic products, siltation, and the conversion of more and more wetlands into agriculture to meet the demands of a rapidly growing population (Mustain Billah 2003). Given the critical importance of natural aquatic resources in the economic lives of rural people, they have played a central role in maintaining poor people's livelihoods in Bangladesh. Over the past couple of decades, community-based management of natural resources, or common-pool resources, has become a common strategy for both improving resource management and empowering local communities, based on concepts such as co-management, local ecological knowledge, the recognition of local institutions, and the establishment of common-property regimes (Sultana and Thompson 2003).

In Mokosh Beel, the project study area, co-management has been carried out over the past decade (2000–2010), through both the Management of Aquatic Ecosystems through Community Husbandry (MACH) project and the Integrated Protected Area Co-management (IPAC) project, to promote sustainable aquatic resource management

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and rural poverty alleviation. This research focuses on how the co-management approach has impacted sustainable management of resources in beels, as well as the rural livelihoods of poor people and fishers, who earn their livelihood from these open inland water bodies.

I have critically analyzed the different interventions that were undertaken through these projects to ensure sustainable fisheries management in beels and the positive impacts on the livelihoods of the rural poor. The findings from this research may serve as a guide for policymakers, government officials, and NGO workers, and could be useful for the beneficiaries of wetland resources, namely fishers, resource user group (RUG) members, federation of resource user group (FRUG) members, and resource management organization (RMO) members.

The overall aim of this study is to determine how the co-management approach contributes to sustainable wetland management and rural people's livelihoods. The specific objectives are to:

1. Analyze how, specifically, the co-management arrangement contributes to the sustainability of fisheries resources;
2. Assess the impact of co-management on the livelihoods of members of resource management organizations (RMOs) and resource user groups (RUGs); and
3. Identify the roles and responsibilities of members of RMOs and RUGs under the co-management arrangement.

## Background

Mokosh is a perennial beel located to the west of the Turag River in Kaliakair Upazila of Gazipur District. The Turag-Bangshi site is located just north of Dhaka and is typical of most low-lying floodplains of Bangladesh. The beel is connected to the Turag River via the Sauria-Solahati canal. At the beginning of the rainy season, as floodwaters enter the upstream portions of the Bangshi, water spills over the riverbanks through different canals that connect the river to adjacent beels, including Mokosh Beel. Through these canals fish move from the river to the beels and the adjacent floodplain areas for spawning or nursing, and then later - as water recedes after the monsoon - the fish move into the deeper perennial portions of the beels or back into the river. In the dry season, water levels in the local rivers and in Mokosh Beel are reduced due to vast ground and surface water extraction for *boro* (dry season rice) irrigation. During drought years, flows cease in the otherwise perennial Turag River, while fish remain only in the deepest portions of the beels and the river. Thus, annual fish production depends largely on the size of the breeding populations that survive in the dry season (Chowdhury and Clemett 2006). In the monsoon season, the area of this beel is around 323.89 hectares and in the dry season, it is only about 8.09

hectares. There are about 2.32 hectares of *khas* land (state-owned property managed by the local government administration) in the beel. The beel is surrounded by several villages, including Taltoli, Baraibari, Satura-Solahati, Haturiachala, Laskarchala, Mazukhan, Ratanpur, Gopinpur, Amdair, Kouchakuri, Matikata, and Sinabahor (see Figure 1).

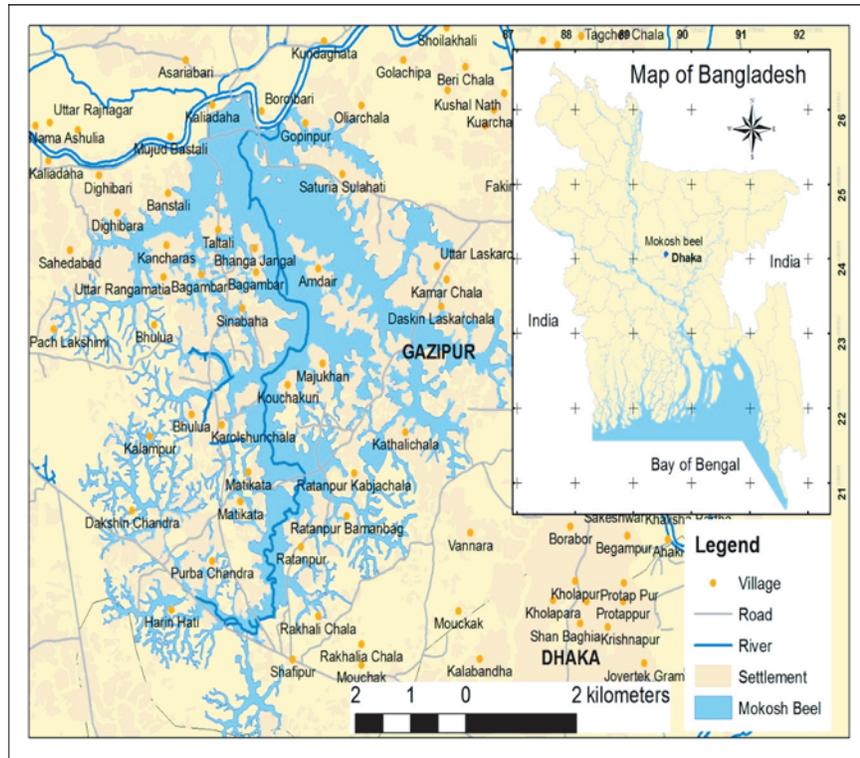


Figure 1: Map of Mokosh Beel and the study area (Source: IPAC)

## Methods

I chose Mokosh Beel as the study area because it has been an established and successfully running co-management site since June 1999 (Winrock 2010). The area has also been identified by the IPAC project as an important protected area. Both RMOs and RUGs are actively involved in the area. I was thus able to measure the benefits that fishers derive from co-management around the beel and also assess to what extent their standard of living has improved. The study was conducted from August to December 2011, during which time I made eight visits: two to Mokosh Beel, once in September (wet season) and once in December (dry season); and six visits to three villages (two to each).



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I collected both qualitative and quantitative primary data from members of one RMO, three RUGs, and one federation of resource user groups (FRUG). I used field visits and observations, consultations with community leaders and key informants, personal interviews, and focus group discussions (FGD). Relevant secondary data were also collected from the Department of Fisheries (DoF), the Forest Department (FD), the Department of Environment (DoE), other relevant government organizations, the WorldFish Center, the local IPAC office, the MACH project, and NGOs that have worked on wetland resources management and promoting rural people's livelihoods in Bangladesh.

I selected three villages-Haturiachala, Amdair, and Gopinpur-based on the fact that they are predominately surrounded by the beel, easily accessible, and contained a majority of MACH beneficiaries. I used random sampling to select a total of 30 members, both male and female, from the three different RUGs in the villages. Interviews were conducted using a prepared semi-structured questionnaire. Each interview took 25 to 30 minutes. Respondents did not maintain written records, so they answered me based on their memory. I made all possible efforts to minimize recall errors from respondents. If any respondent had difficulty understanding any questions or technical issues, utmost care was taken to clarify these.

The qualitative data were collected through focus group discussions with RMO and FRUG members, concerned local and central government officials, project-implementing staff involved in Mokosh Beel resource management, and other stakeholders. At the beginning of each focus group discussion, I introduced myself, explained my research objective, and then invited them to join the discussion. For the focus group discussions, I used a list of pre-determined questions to explore their understanding of different issues: co-management and the overall management of the beel; the benefits, problem-solving capacity, experiences, and responsibilities in co-management and fisheries conservation; the impact of pollution on beel fisheries; and the sustainability of co-management practices.

Finally, I checked, edited, and recorded the collected data digitally, and arranged these data according to my research objectives. Although all of the interviewed people received benefits from co-management interventions in Mokosh Beel, I categorized respondents into two major groups: (1) fishers who directly or indirectly depend on fishing and (2) non-fishers who gain their livelihoods from professions other than fishing. The research employed both qualitative (descriptive) and quantitative analysis techniques.

One limitation of my study was that I could not find a RUG that included both male and female members, so I selected one male RUG from Gopinpur (a fishing village), another male RUG from Haturiachala (a non-fishing village), and one female RUG from Amdair (another non-fishing village).

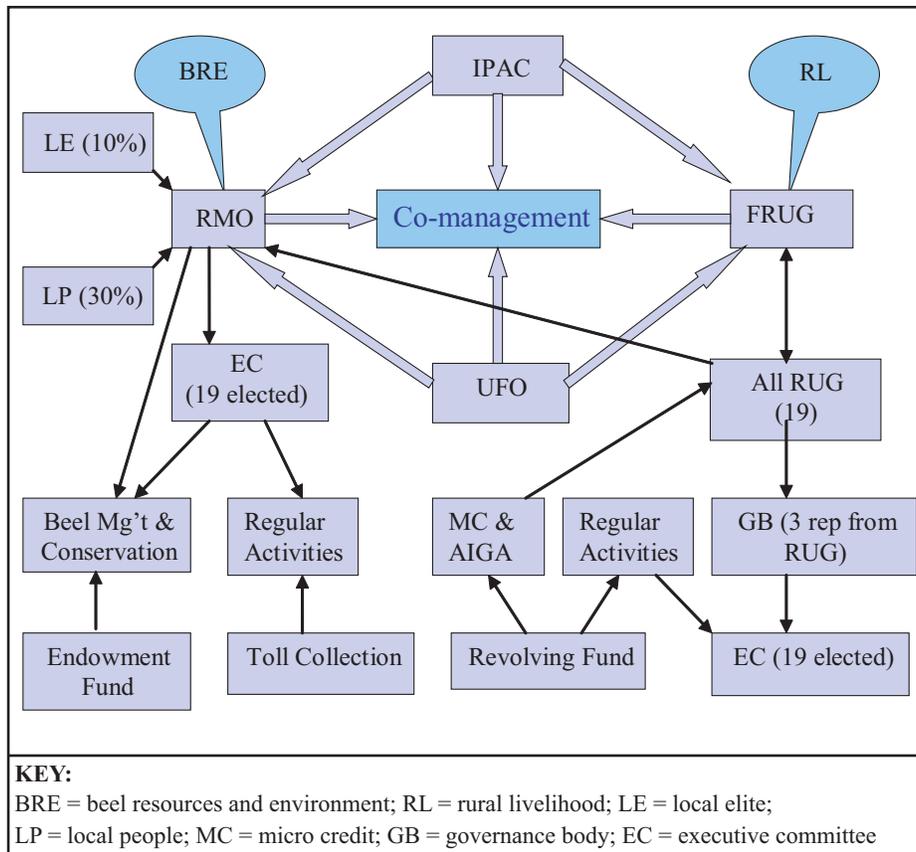
## Results and Discussion

### *Institutional Arrangement of Co-management in the Study Area*

The Mokosh Beel RMO, which consists of 166 members 60 percent of whom are RUG members, 30 percent of whom are local people, and 10 percent of whom are local elites is a community-based institution developed in the Mokosh Beel area for wetland resource management. Women represent 30 percent of all RMO members. During my field study, all respondents from different strata including local stakeholders, local leaders and elites, and IPAC personnel openly explained that RMOs had positively changed the traditional pattern of beel management. This happened because the RMO has linked poor community people and resource users' rights to beel fisheries and created an interface between the community and aquatic property regimes.

There are nine fish sanctuaries, of which one was an initiative by the government and the other eight were established locally. These sanctuaries provide permanent habitat for fish and other aquatic wildlife. Fish harvesting is strictly restricted throughout the year. Other parts of the beel are also controlled during the three month breeding season from March to May, when the fishers are provided with additional livelihood support, including supplies of livestock and small loans for these or other alternative income-generating activities (AIGAs). From March to May, the Fish Conservation Act is enforced with the collaboration of the RMOs and the Kaliakair Upazila fisheries office (UFO) through different kinds of initiatives, such as arranging regular monthly meetings between the UFO and rural community members, and instituting a mobile court (a "court" arranged on a boat, whereby a fisheries officer is granted judicial authority to interpret and enforce the Fish Conservation Act, to discourage use of destructive gear and fine guilty fishers). The goal of the RMO executive committee (EC) is to manage fisheries resources and to create awareness among local people and group members by holding village meetings, making loudspeaker announcements, conducting rallies, and creating human chains, demonstrations, dramas, and so on. Key informants told me that the Mokosh Beel resource management organization is governed by 19 elected executive committee members, five of whom are women. Management and conservation duties and responsibilities such as maintenance of the sanctuary, toll collection, guarding of the beel, and helping the mobile court to collect small-mesh gill nets and other destructive gear are well defined for all group members. The MACH project established an endowment fund in the joint account of the District Commissioner (DC) and the District Fisheries Officer (DFO) to provide technical and institutional support. Furthermore, the executive committee prepared a proposal incorporating sanctuary maintenance and an awareness-raising program to submit to the Upazila Fisheries Committee (UFC) in order to collect the required resources from the endowment fund in their joint account (president, secretary, and treasurer). The interest gained from this fund is used to support the activities of the RMO and the UFC, and locally collected tolls are used to meet the different costs of the executive committee.

The Mouchak-Madhyapara federation of resource user groups (FRUG) consists of 372 members of whom most are poor and landless, and about 50 percent are women. Members are directly engaged in co-management activities and are provided with resources for AIG activities, training, and small loans (Mohammad 2009). The executive committee of the FRUG has 19 members who are elected every two years in a democratic way. The tasks and responsibilities of these EC members vary. The committee organizes regular monthly meetings with a specific agenda, distributes small loans to facilitate AIGAs, discusses different problems and probable solutions, and observes various national days. The MACH project created a revolving fund to promote AIGAs among the RUG members. The interest from this fund is used to support different activities of the EC. Figure 2 shows the institutional arrangement of co-management organizations in the Mokosh Beel area.



**Figure 2: Co-management institutional arrangements in Mokosh Beel**

It is essential to design suitable institutions that can efficiently contribute to protecting the dynamic capacity of natural aquatic biodiversity as well as to securing human well-being (Hanna *et al.* 1996). The MACH intervention tried to develop institutional capacity, through the RMOs, RUGs, and FRUGs, to ensure sustainable management of aquatic resources and the livelihoods of local aquatic resource users.

At present, the activities of the MACH project are being continued by the Integrated Protected Area Co-management (IPAC) program, which is directly monitoring AIGAs and providing technical assistance to the RUGs. I found that, as a result, the RMOs, FRUGs, and RUGs are working properly and that this institutional arrangement has organized people systematically to support their livelihoods and to enhance the beel fishery. These results differ from those of Momi (2011), who found that fishers of Alua Beel did not know about the activities of the IPAC program.

### ***Impact of Co-management Initiatives on Rural People***

***Demographic features of respondents.*** I divided respondents into two major categories, fishers and non-fishers. First, I analyzed their demographic characteristics and then tried to identify the benefits they received from co-management. The respondents were of different ages. Among the 30 respondents, the largest age class was 30–40 years (40%), followed by 41–50 years (30%), below 30 years (23%), and above 50 years (13%). I also collected data regarding the education levels of the respondents. Most of the respondents (33%) had completed primary education, while 30 percent have no formal education (i.e. they could sign their names, read, and calculate only), and 27 percent had completed secondary education. There are a few respondents who could only sign their names, and no respondents were found to have completed school above the secondary school certificate level. Among the five categories, 60 percent of the respondents had completed their basic education. Most of the people in the fishers group were less educated before (they could sign their names only), but their education level has improved through a literacy campaign under the MACH project.

***Reasons for joining co-management organizations.*** I asked participants why they joined the co-management organizations. They expressed different reasons, which I categorize into three major categories economic, social, and cultural. I found that most of the respondents (61%) joined the co-management organizations to derive economic benefits, followed by those who participated to achieve cultural advantages (37%) and those who joined for social reasons (21%). The specific reasons that respondents gave are shown in Table 1.

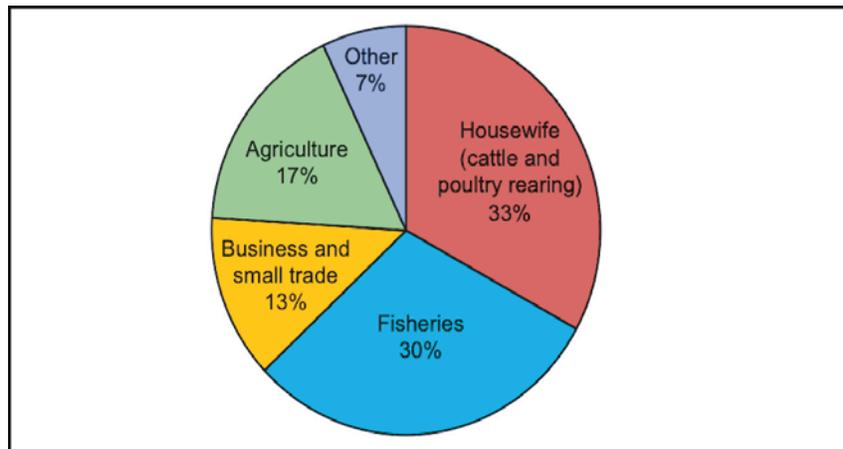
**Table 1: Reasons for joining co-management organizations**

Reasons for joining	Percentage of respondents*
<b><i>Economic reasons (61%)</i></b>	
Increase availability of fish in terms of production and types of fish	12 (40%)
Create alternative income and employment opportunities	18 (60%)
Increase savings	22 (73%)
Collect loans for alternative income-generating activities	25 (83%)
Increase in monthly income	15 (50%)
<b><i>Social reasons (21%)</i></b>	
Conserve beel fishery and wildlife	7 (23%)
Protect aquatic environment	5 (17%)
Social welfare	3 (10%)
Social empowerment	8 (27%)
Increase social security	9 (30%)
<b><i>Cultural reasons (37%)</i></b>	
Get training	11 (37%)
Improve literacy	8 (21%)
Increase knowledge	9 (30%)
Decrease dependence on fish	17 (57%)
Increase mobility	10 (33%)

\* Note: Due to multiple responses, percentages do not add up to 100 percent.

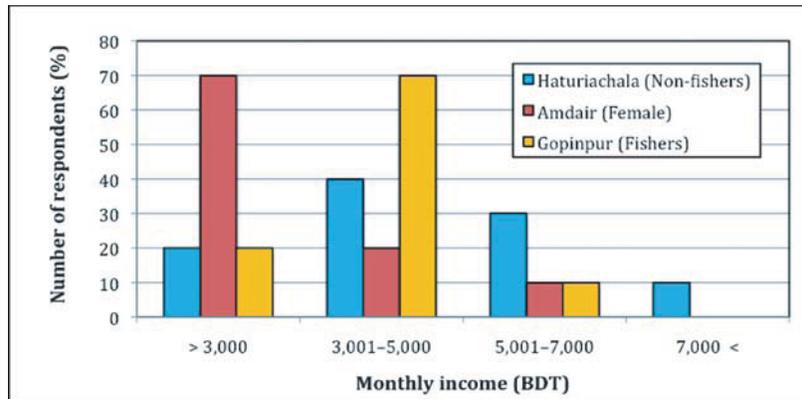
**Micro-credit and AIGAs.** The MACH project established a revolving fund (1.3 million BDT) for the Mouchak-Madhyapara FRUG in the joint account of the president, secretary, and treasurer to disperse micro-credit loans to the RUG members for developing their livelihoods through AIGAs. Ninety percent of the respondents took loans ranging from 5,000 to 15,000 BDT. As a result of this, some respondents switched to new occupations. Through my survey, I determined that 30 percent of the informants were engaged in fishing, 17 percent worked in agriculture, 13 percent were involved in business and small trade, and 7 percent were engaged in other work including tailoring and cow fattening. One third of my interview subjects were female. All of these were housewives, but they also earned money by rearing cows or poultry or engaging directly or indirectly in small trade. I found that most of the participants were engaged in different AIG activities, supported by taking small loans from the FRUG, as their primary or secondary sources of income. They were motivated through various training and awareness-raising programs. According to the MACH completion report published in 2007, respondents chose various types of AIGAs, including dairy production (19%), small trading (19%), fish resale (20%), cattle rearing (14%), poultry rearing (7%), rice husking or resale (21%), and rickshaw pulling (11%), which were different from those in my data. This is most likely because I selected a limited sample of 30 participants, of whom 10 were women (housewives), whereas the MACH report had a total of 4,058 respondents. In the fishers group, about 33 percent collected fish year round, and the other 67 percent fished only during the season when fish were most available. During the lean season

of fishing, they engaged in different income-generating activities, such as small trade, agricultural labor, and day labor. It is interesting that only 10 percent (three participants) are full time fishers. This could be a result of increased involvement in co-management. Alternative income generation and training activities can lead fishers to shift from sole reliance on fishing for their livelihoods to engaging in other trades and businesses (Winrock 2007). The occupational status of respondents is represented in Figure 3.



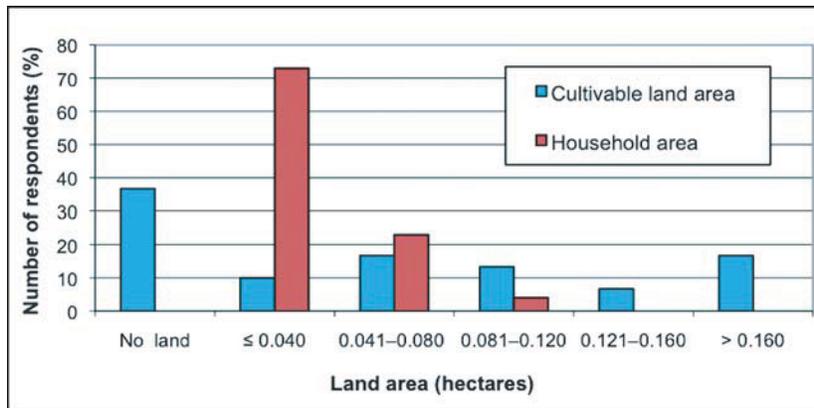
**Figure 3: Main occupations of RUG members**

The analysis also revealed that most of the respondents (43%) were moderate earners, earning only 3,001 to 5,000 BDT monthly to meet their family expenditure, while 37 percent earned less than 3,000 BDT per month, and 17 percent earned from 5,001 to 7,000 BDT per month. The average monthly income varied in the different villages due to differences in the occupations and educational levels of respondents. In Haturiachala, respondents' incomes were higher than those in the other two villages. This may be due to the fact that they were more educated and derived their income from a greater variety of sources. Most female respondents in Amdair village had very low incomes (less than 3,000 BDT) as they are mainly housewives engaged in cattle and poultry rearing. The average per capita annual income of beneficiaries in the study villages is 49,218 BDT, which is about 4.2 times higher than the per capita annual income (11,700 BDT) of beneficiaries observed in a baseline survey conducted by MACH project personnel in 1999 (Winrock 2007). The distribution of monthly income of respondents is presented in Figure 4.



**Figure 4: Average monthly income of respondents**

Through my survey, I identified the housing conditions and land ownership status of the participants. I observed that among the 30 respondents, about 19 (63%) live in a mud house with a tin roof, seven (23%) live in a house made of tin, two (7%) reside in semi-permanent houses, and two (7%) live in permanent houses. All respondents own the land for their house, ranging from 0.016 to 0.121 hectares, while some of them have no cultivable land. Respondents noted that their housing condition and land status had improved, due to an increase in income. The land area occupied by the beneficiaries is shown in Figure 5.



**Figure 5: Land status of respondents**

**Benefits from aquatic resource management and conservation.** I conducted two focus group discussions (FGDs) to gather data about the socio-economic benefits gained by the resource users from the management and conservation of beel resources. I collected different types of data and categorized them accordingly. I determined the direct and indirect benefits received by the beneficiaries through co-

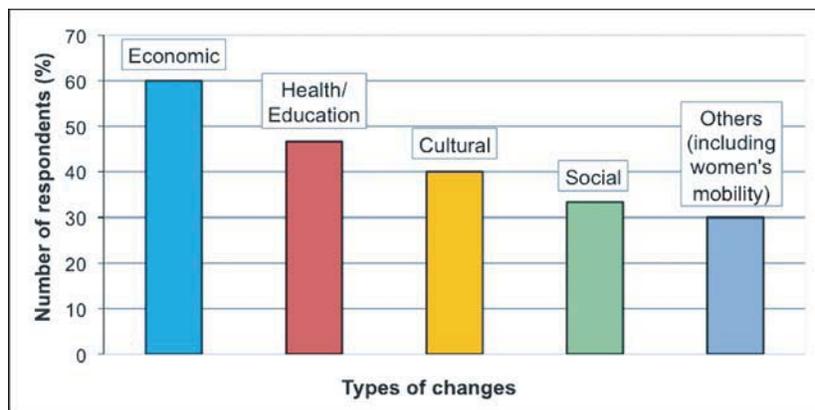
management intervention in the study area by asking different types of questions. The results are classified in Table 2 by type of benefit.

**Table 2: Respondents’ perceptions of direct and indirect benefits from co-management**

Direct benefits	Number of respondents (percentage)*	Indirect benefits	Number of respondents (percentage)*
Increased monthly income	24 (80%)	Improved sanitary facilities	27 (90%)
Increased savings	23 (77%)	Increased awareness	20 (67%)
Employment opportunity	20 (67%)	Improved educational facilities	15 (50%)
Alternative income source	18 (60%)	Social welfare	14 (47%)
Wetland restoration	16 (53%)	Social empowerment	13 (43%)
Awareness and observation of national/international holidays (e.g. Women’s Day)	16 (53%)	Establishment of infrastructure (e.g. roads, market, health center, schools)	12 (40%)
Increased fish consumption	12 (40%)	Increased women’s mobility	12 (40%)
Improved management skills	9 (30%)	Development of housing facilities	11 (37%)
Increased fish catch	8 (27%)	Environmental protection	7 (23%)
Higher catch of different fish species ( <i>Cirrhinus mrigala</i> , <i>Nandus nandus</i> , <i>Labeo rohita</i> )	7 (23%)	Enhanced social (livelihood) security	6 (20%)

\*Note: Due to multiple responses, percentages do not add up to 100 percent.

The co-management approach has had positive impacts on the livelihoods of the people living around the Mokosh Beel area. I categorized these impacts into five types of changes: economic (e.g. income, small loans, employment, production); cultural (e.g. changed attitudes, increased awareness), social (e.g. social empowerment, social welfare); health and education; and other changes (e.g. women’s mobility, improved environment). The types of changes experienced by respondents are shown in Figure 6.



**Figure 6: Changes in well-being among participants**

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**Respondents' roles in wetland resource management and conservation.** In my study, most of the respondents and local people around the Mokosh Beel area were familiar with the main objectives of co-management interventions to uphold rural people's livelihoods and to enhance the sustainability of management of aquatic resources through different co-management techniques. One of the reasons behind this awareness could be that they have actively participated in various awareness-raising and social activities, which are specifically designed to help people comprehend the short-term and long-term effects of wetland resource management and conservation. Respondents were exposed to different awareness-raising activities, including village meetings, loudspeaker announcements, rallies, human chains, and participation in mobile courts, to motivate villagers, family members, and others. During the MACH period, they also took part in folk dramas to raise people's awareness about wetland management and conservation.

Many common fish species are found in Mokosh Beel, including small hilsha (*Hilsa ilisha*), mrigal (*Cirrhinus mrigala*) and rui (*Labeo rohita*). My research shows that meni (*Nandus nandus*) is a revived fish species in Mokosh. Further, kalibaus (*Labeo calbasu*), ghaira (*Clupisoma garua*), nandina (*Labeo nandina*), bagha ayre (*Bagarius bagarius*), pabda (*Ompak pabda*), batashi (*Pseudeutropius atherinoides*), and kakila (*Xenentodon cancila*) are all rare species, and tatkini (*Cirrhinus reba*), fasa (*Setipinna phasa*), chital (*Notopterus chitala*), and sarpunti (*Puntius sarana*) are extinct in Mokosh Beel.

I also investigated respondents' roles and responsibilities regarding the management and conservation of the beel. I gathered data from the participants of fisher and non-fisher groups about their responsibilities at four stages: decision making and planning, organization, monitoring, and implementation. From the FGDs, I discovered that local elites and non-fishers dominated the decision-making and planning stages, and most respondents (both fishers and non-fishers) contributed in the implementation stage, during which most fishers engaged in the guarding and maintenance of the sanctuary. Respondents of these two groups helped ensure that the duties and responsibilities at both the organizational stage (organizing monthly meetings, arranging village meetings, folk dramas, and rallies) and the monitoring stage (monitoring destructive gear use and availability of fishes) were met. Table 3 presents the knowledge of duties and responsibilities reported by the RMO respondents.

**Table 3: Knowledge of duties and responsibilities of respondents in the RMOs**

Duties and responsibilities	Non-fisher group Number of respondents (percent)	Fisher group Number of respondents (percent)
<b>Decision-making stage</b>		
Decision making	1 (3%)	0 (0%)
Activity planning and preparation	2 (7%)	0 (0%)
Budget preparation	2 (7%)	0 (0%)
Establishing rules and regulations	1 (3%)	0 (0%)
<b>Organizing stage</b>		
Organizing monthly meetings	2 (7%)	0 (0%)
Arranging rallies, folk dramas, village meetings	3 (10%)	2 (7%)
<b>Monitoring stage</b>		
Monitoring fishing ban periods, use of destructive gear, fish catch amount/size	4 (13%)	7 (23%)
Toll/tax collection	2 (7%)	1 (3%)
<b>Implementation stage</b>		
Rice cultivation	7 (23%)	4 (13%)
Fishing activity	4 (13%)	11 (37%)
Poultry and cattle rearing	6 (20%)	2 (7%)
Tree planting and maintenance	3 (10%)	0 (0%)
Sanctuary protection and maintenance	8 (27%)	8 (27%)
Establishment of seasonal sanctuary	2 (7%)	7 (23%)
Beel protection/guarding	3 (10%)	9 (30%)

The success of co-management depends on the active participation of members at all levels, but my research showed that non-fisher elites seem to be the main decision makers, although they have tried to share the benefits equally with all members. This contradicts the argument made by Rahman *et al.* (2002) that the rich and powerful elites capitalize more aquatic resources and take most of the benefits from traditional state management structures by using their political power, authority, bureaucracy, and market mechanisms. The reason behind this may be that, at present, the resource users are more aware of their rights due to their participation in different co-management interventions and institutions.

The participants in the FGD also mentioned some problems, such as industrial pollution and land encroachment by private entrepreneurs. Effluents discharged from various industries in the Mokosh Beel area including textile production (dyeing,



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printing, and washing), large-scale commercial poultry farming, and pharmaceutical manufacturing have had a large impact on the beel environment and wetland biodiversity, as well as on human beings. Due to ongoing pollution, there has been a steady reduction in fish production, aquatic biodiversity (aquatic flora and fauna), biomass, and migratory and aquatic bird populations in Mokosh Beel. Pollution has also contributed to the prevalence of asthma, various skin diseases, and a loss of food security in the area. Moreover, private entrepreneurs have occupied wetlands to develop housing facilities, which have also decreased the overall area of the beel. The amount of industrial effluents discharged into the Mokosh and Turag-Bangshi water systems has been estimated at 30 billion liters annually (Winrock 2007). According to secondary data collected from the IPAC office, fish production in Mokosh Beel was 147 kilograms/hectare per year in 2010–2011 (IPAC 2011). This production is much lower than Bangladesh’s average beel fish production of 615 kilograms per hectare per year in 2010 (DoF 2011). The only reason mentioned by the respondents for this phenomenon is pollution. They added that if there were no pollution, beel fish production would increase to four to five times the present production rate. My survey results, which confirm the findings of Akter (2011), indicate that some fishers may have switched to other professions due to the decline in the availability of fish caused by pollution. Local people have taken many initiatives, including meeting with the industrialists and forming human chains to protest such activities, but they haven’t made significant progress in this regard. They have demanded government intervention to mitigate such problems, since the government has established the DoE to monitor environmental hazards.

In addition, I asked the participants if they would be able to run a co-management program themselves after termination of the IPAC project. They expressed doubt, indicating that, if monitoring were not run in a proper way, then some beneficiaries could use it for their personal interest and gain. This would likely hamper the sustainability of the co-management approach.

## Conclusion

Co-management has played a great role in improving rural peoples’ livelihoods as well as in wetland conservation. Recognizing the interrelationships between rural community livelihoods and aquatic resource conservation, the MACH project has systematically executed a wide range of interventions to restore the productivity of wetland ecosystems by introducing sustainable aquatic resource management practices with the joint involvement of community people and local government officials. The duties and responsibilities of the RMO and FRUG members are very well defined and their activities are supported by different funding sources. Rural people are engaged in co-management organizations mainly for the purpose of getting loans, increasing their income, saving money, and supporting increases in fish production and biodiversity.

My research revealed that a wide range of MACH interventions like the establishment of beel sanctuaries, excavation of beels and canals, different awareness-raising programs, trainings, and the distribution of micro-credit for AIGAs have contributed to the enhancement of both beel productivity and rural peoples' socio-economic and cultural status. One very important point is the participation of women in co-management organizations. Currently, women are 30 percent and 50 percent of the members of the RMO and the FRUG, respectively. Women's participation in co-management organizations has increased the women members' mobility, organized them, and empowered them to make decisions. Although many are housewives, they have also engaged in income-generating activities through microcredit loans and training. In my analysis, I found that approximately 90 percent of the resource group users were aware of the co-management interventions, and most people observed the fishing ban rules, motivated other people, and actively participated in different awareness-raising programs. Different AIGAs like tailoring, small trading, cow rearing, and poultry rearing are now popular among the participants. The annual income of respondents has increased significantly, and their housing and land status has also improved. Furthermore, they are very interested in supporting the next generation, both socially and culturally.

In my study, I found that management and conservation activities in Mokosh Beel are on the right track. Some fish that had been extinct at the site have been revived due to co-management interventions. I also identified some fish species that have become rare or extinct due to pollution. Pollution resulting from unplanned industrialization is very alarming in this area. Rapid population growth, unplanned urbanization, industrial growth, and land encroachment have all had negative impacts on rural people's livelihoods and the wetland environment. Over the last decades, this growth has reduced the availability of fisheries resources and disturbed wildlife. As a result, populations of many migratory birds and a variety of aquatic flora and fauna have decreased. This has also reduced people's recreational opportunities and adversely affected human health. People are losing their ability to make a livelihood from fishing and have thus switched over to other professions. Men have also involved their wives in the RUGs, resulting in an increase in the number of female RUG participants in the Mokosh Beel area. This may have a positive impact on rural peoples' livelihoods, though this requires further study. These new members in the RUG demand training for AIGAs, but the present IPAC project only monitors activities in the RMO and FRUG, and gives technical assistance to them, which is not sufficient to meet the needs of all stakeholders who rely on the beel. I have three recommendations to rectify these shortcomings:

1. The Government of Bangladesh should take a strong initiative to reduce industrial pollution through proper planning, active monitoring, and ensuring the use of effluent treatment plants (ETPs) by industries.
2. The Department of Environment should make significant efforts to improve the present situation of pollution.

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3. IPAC support should be broadened to include different training programs and to increase support for AIGAs among rural people.

Finally, all participants, including officials from the local and central governments, recognize the positive achievements of the MACH and IPAC interventions, but the sustainability of the co-management approach may be hindered after termination of the IPAC project due to a lack of proper monitoring and biased and dishonest management by some of the beneficiaries.

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