Inland Fisheries Management in Bangladesh

Edited by
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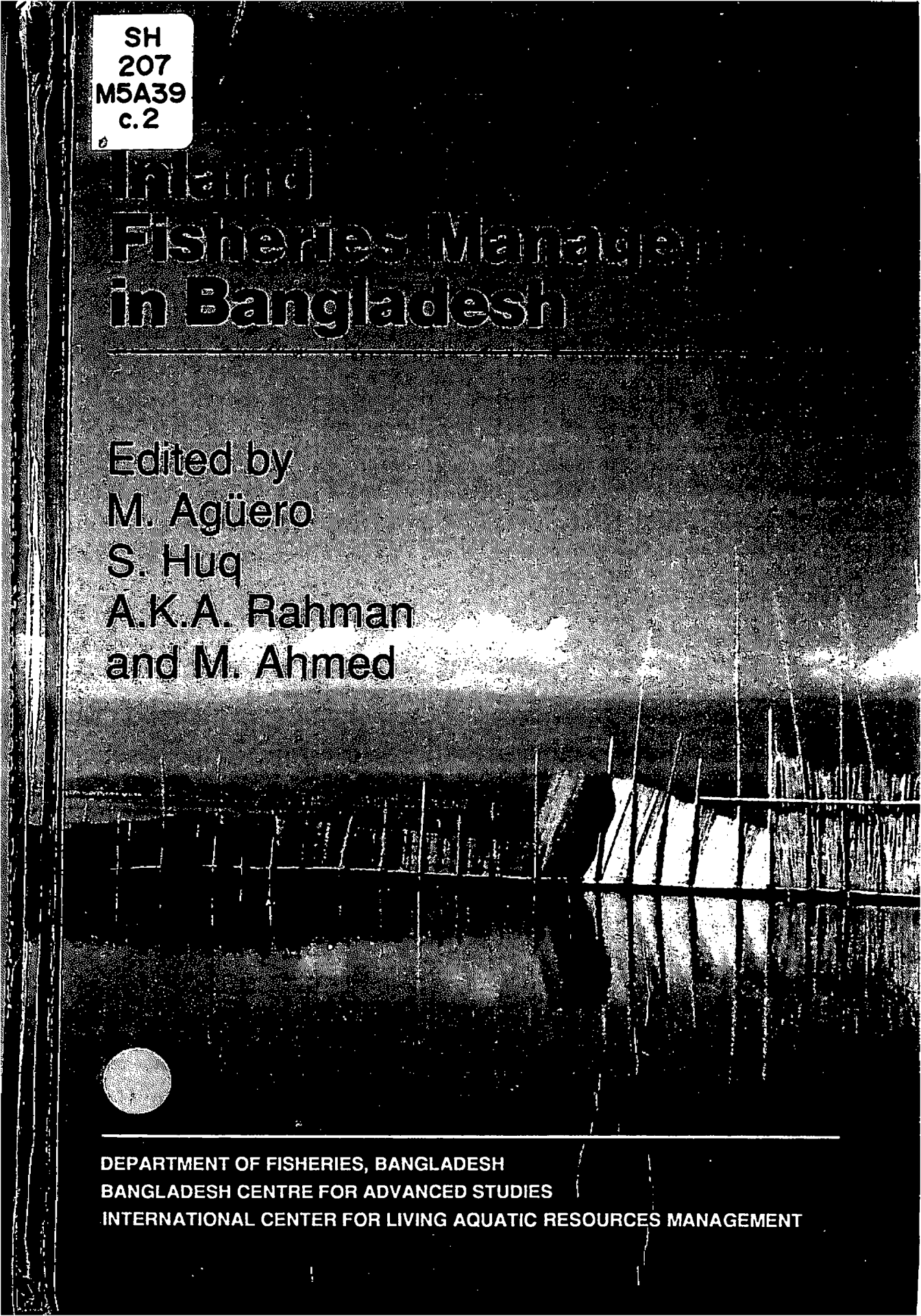
and M. Ahmed



DEPARTMENT OF FISHERIES, BANGLADESH
BANGLADESH CENTRE FOR ADVANCED STUDIES
INTERNATIONAL CENTER FOR LIVING AQUATIC RESOURCES MANAGEMENT

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Edited by

Max Agüero
Saleemul Huq
A.K. Ataur Rahman
and
Mahfuzuddin Ahmed

1989

Department of Fisheries, Bangladesh
Bangladesh Centre for Advanced Studies
International Center for Living Aquatic Resources Management

Inland Fisheries Management in Bangladesh

Proceedings of the workshop on
"Experiments in New Approaches to the Improved
Management of Open-water Fisheries in Bangladesh"
Dhaka, Bangladesh, 9 - 10 January 1989

Organized by
- the Bangladesh Department of Fisheries
- Bangladesh Centre for Advanced Studies, and
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Cover: A temporary barrier placed across the river completely blocking the passage of fish; an example of destructive fishing practice in the inland open waters of Bangladesh. Photo by M. Agüero.

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Preface

The Department of Fisheries (DOF) of the Government of Bangladesh, The Ford Foundation, Dhaka, and the International Center for Living Aquatic Resources Management (ICLARM) jointly organized a national workshop, 9-10 January 1989, on Experiments in New Approaches to the Improved Management of Open-water Fisheries in Bangladesh.

The workshop was an outcome of the Project being implemented by DOF with funding provided by The Ford Foundation and technical assistance of ICLARM under the New Fisheries Management Policy of the Government of Bangladesh adopted in 1986. To this effect, a management team at the DOF and a monitoring team consisting of selected members of the Bangladesh Centre for Advanced Studies (BCAS) have been working in close coordination and with the technical assistance of ICLARM for the last two years.

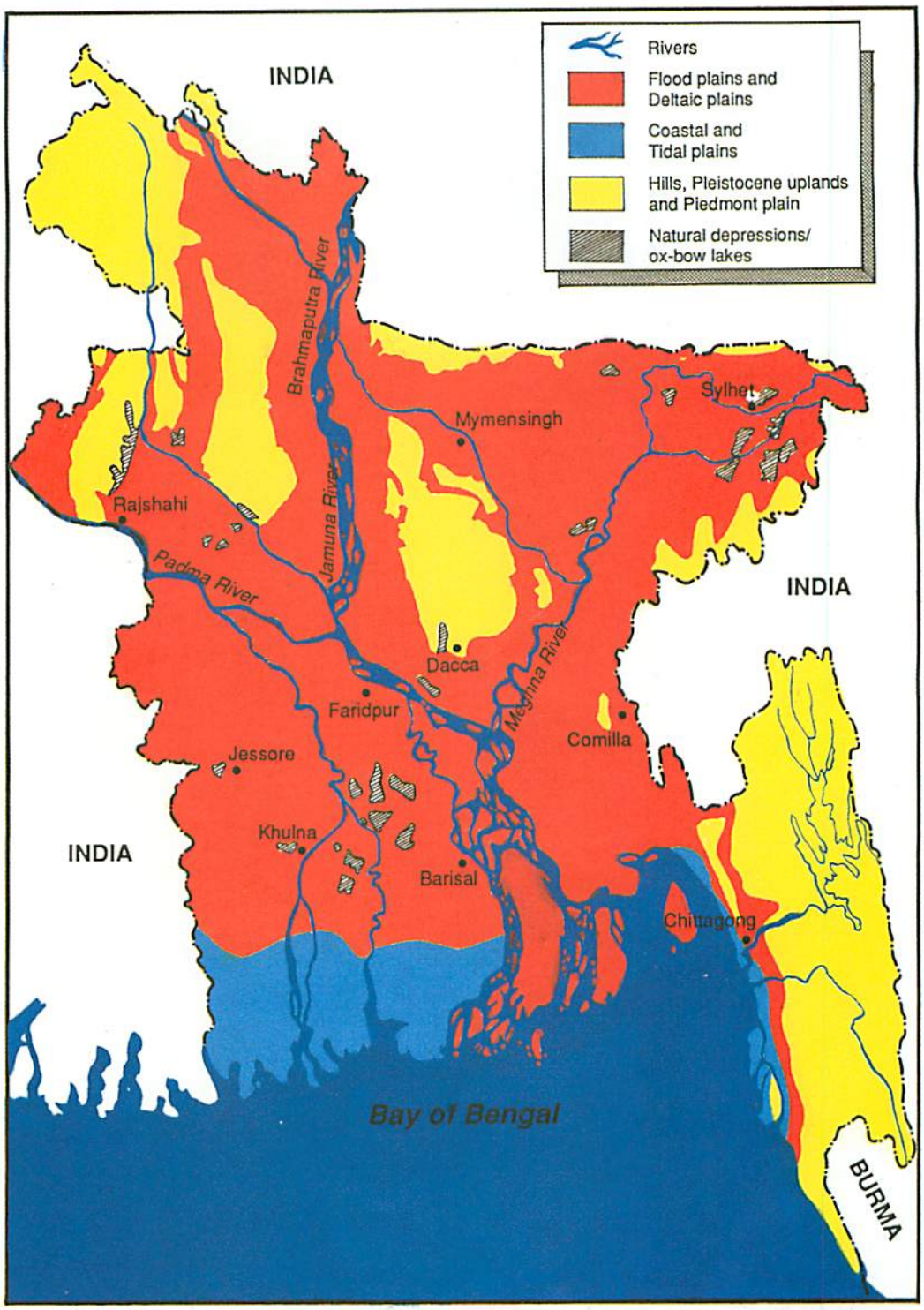
The objective of the workshop was to discuss preliminary results and experiences gained during the last two years (1987-88) in the process of introducing and experimenting with new and improved methods of management in the open-water inland fisheries of Bangladesh.

This volume contains the proceedings of the workshop, includes the keynote and inspi. itional addresses made during the inaugural session of the workshop, two background papers and eight subject matter papers presented during the working sessions, and the panel discussions and recommendations of the workshop.

The workshop was held at the Bangladesh Agricultural Research Council (BARC) Auditorium, Airport Road, Farm Gate, Dhaka, Bangladesh. Mr. Sardar Amjad Hossain, Minister of Fisheries and Livestock of the People's Republic of Bangladesh inaugurated the workshop which was attended by approximately 150 participants.

We would especially like to thank Dr. Daniel Pauly of ICLARM, for reading the entire draft of these proceedings and making important suggestions for improving many of the contributions. Without the efficiency and patience of Miss Sandra Abeto, who spent many hours and several week-ends with the microcomputer processing, correcting and re-correcting the various drafts, this volume could have not been released in only few months after the workshop. We also thank the Information Program staff of ICLARM for their assistance with maps, drawings, designs and final printed output. Finally, we would like to thank our Project Secretary, Mrs. Zerina Ekram for her invaluable help in timely securing all manuscripts, materials and logistics for the workshop.

The Editors
June 1989



Map of Bangladesh. River systems and physiographic regions.

Welcome Address

Mr. Mohammed Ahsanullah
Director, Department of Fisheries
Ministry of Fisheries and Livestock
Government of the People's Republic of Bangladesh

Aassalamu Alaikum, Ladies and Gentlemen.

On behalf of the organizing committee of the workshop on "Experiments in New Approaches to the Improved Management of Open-water Fisheries in Bangladesh", I wish to welcome in this inaugural session our Chief Guest, the Honorable Minister for Fisheries and Livestock (MOFL), Government of the People's Republic of Bangladesh, *Janab* Sardar Amjad Hossain; our special guest, the Secretary of the Ministry of Lands, People's Republic of Bangladesh, *Janab* Mokammel Haq; our Chairman for the inaugural session, Secretary of the Ministry of Fisheries and Livestock, People's Republic of Bangladesh, *Janab* Md. Ahsar Ali Sarkar, the representatives from Government and non-government organizations, national and international development agencies, especially the representatives of The Ford Foundation, the International Center for Living Aquatic Resources Management (ICLARM) and the Bangladesh Centre for Advanced Studies (BCAS) who have been instrumental in organizing today's seminar. I would like also to welcome the delegates to and participants of today's seminar. Welcome everybody.

The Department of Fisheries (DOF) in collaboration with ICLARM, have organized this seminar to discuss preliminary results and experiences gained during the last two years in the process of introducing and experimenting new and improved methods of management in the open-water inland fisheries of Bangladesh.

At this point, I would like to give a brief introduction of the New Fisheries Management Policy (NFMP). Our inland fishery operates under complex biological, technological, climatic, social, economic, political and institutional conditions. Historically, fishing areas in the inland open waters have been leased out for harvesting the fish. Usually, the lessee is a middleman who becomes the owner of the exclusive rights to harvest fish in a particular area, upon payment of a leasing fee to the government. The process is replicated through sub-leasing. He may hire fishermen to harvest his fish or he may sell fishery rights to fishermen.

Unfortunately, this system has failed to serve the national interest of conserving the fisheries resources and protecting the economic fortune of the fishermen. On the contrary, the middlemen and wealthy private financiers have been able to exploit the fisheries to their own interest at the cost of resource sustainability as well as the misery of the fishing community. As a consequence resources have become reduced to lower productivity and the economic conditions of fishermen have remained low or even deteriorated.

Nevertheless, the role of fishery sector as a cheap source of animal protein food, employment, income and foreign exchange earnings in our national economy remains significant. Therefore, rather than being a passive partner of management by administering the leasing procedures and collecting some token revenues, a more direct participation of the public sector in the process of overall management of the fisheries has become necessary. The need for introducing new methods of management has been suggested by national and international experts as a viable solution to the problem of utilizing our inland fisheries resources to the country's best interest.

The NFMP got the kind approval of the Honorable President Hossain Mohammad Ershad in 1986. The main ideas in the new policy were the gradual abolition of the short-term public auctioning or leasing system of fisheries in five to ten year's time; freeing of the genuine fishermen from the oppression of the middlemen financiers; and ensuring the conservation and propagation of fishery resources to obtain a sustained increase in fish production.

Accordingly, a system of restrictive licensing of water bodies to genuine fishermen or groups of fishermen was adopted and the MOFL was initially entrusted the responsibility of implementing the new policy. Considering the administrative difficulties, manpower constraints and lack of experience in implementing a comprehensive policy, the government decided to proceed in a phased manner and the new policy was, therefore, introduced in selected waterbodies on a pilot scale. In line with the phase-wise implementation of the new management policy, the DOF in 1986 initiated an experimental project through which the management guidelines of the new policy have been implemented and at the same time, performance of the fisheries under several alternative designs and institutional arrangements are being assessed. To this effect a management team at the DOF and a monitoring team consisting of selected members of the BCAS have been working in close coordination and with the technical assistance of ICLARM for the last two years. In addition to help achieving the major objectives of equity and sustainability as outlined in the New Fisheries Management Policy, it is hoped that the experiment will provide an institutional guideline for future management strategies for the public fisheries and finally build up and establish capabilities within the MOFL and DOF to gain the needed experience in managing our fishery resources.

So far, on the basis of the information gathered by the monitoring works and feedback to the management team and the Ministry the impact of NFMP on productivity, resource sustainability and income distribution has been showing improvement from the traditional system. More concrete results appears to be time consuming and will depend on the successful implementation of the policy in the remaining waterbodies of which the experimental sites are parts.

It is expected therefore that this workshop will achieve the following objectives:

* To share the management and monitoring experiences under the new policy,
* To discuss practical and methodological problems in the implementation and monitoring of the NFMP, and
* To suggest practical and effective strategies in the implementation of the NFMP.

Once again I would like to welcome our chief guest Honorable Minister *Janab* Sardar Amjad Hossain; special guest Secretary *Janab* Mokammel Haq; distinguished guests and the delegates and participants of this national workshop on "Experiments in New Approaches to the Improved Management of Open-water Fisheries in Bangladesh".

Thank you.

Guest's Address

Dr. Charles R. Bailey
Representative
The Ford Foundation
Dhaka, Bangladesh

Honorable Minister, Secretaries, Ladies and Gentlemen:

I am pleased to have been invited to contribute to the inauguration of this workshop on "Experiment in New Approaches to the Improved Management of Open-water Fisheries."

In early 1986, the Ministry of Fisheries and Livestock (MOFL) and The Ford Foundation agreed on the design and funding of a project for the improved management of open-water inland fisheries in Bangladesh. Both the Ministry and the Foundation recognized the important contribution which fish makes to diets and nutrition.

And both also realized that improved management of fisheries could stabilize, and perhaps substantially improve, the incomes of families primarily dependent on fishing for their livelihoods. Concern was also expressed over stagnating production from inland fisheries and price increases which have put regular consumption of fish out of the reach of many people.

The project which resulted from our discussions in 1986 has several objectives.

The first, and principal objective is, to test and develop alternative approaches to managing open-water fisheries, in order to establish, from an administrative point of view, how best to achieve the equity and sustainability goals set out in the government's open-water fisheries policy.

The other project objectives are:

* To collect data that will contribute to improved policy-making and planning, particularly with regard to inter-sectoral water resources allocation;

* To provide institutional guidelines for the management of *jalmahals* into which aquaculture is to be introduced; and,

* To contribute to capabilities, both within the MOFL and the Department of Fisheries (DOF) and among independent researchers, to collect and analyze data essential to the sustained improvement of open-water fisheries management in future.

The Ministry has also involved technical specialists from the Bangladesh Centre for Advanced Studies (BCAS) and the International Center for Living Aquatic Resources Management (ICLARM) based in Manila in this project.

Over the last two years, experimental field work has been carried out in 12 *jalmahals*. Staff of the Department of Fisheries selected these 12 sites from among the approximately 10,000 *jalmahals* under government ownership and management. The selection has been made with the aim of covering a wide range of environmental conditions and geographic areas.

These include:

Segments of major inland and estuarine rivers.

Manageable units of *baors* in the Jessore area.

Manageable natural depressions (*beels* and *haors*) in the Sunamganj and Netrokona areas.

According to the project plan, in six of the 12 *jalmahals* the DOF was to introduce new forms of fisheries management, including licensing. Measures were planned to ensure that:

* the waters are fished by licensed fishermen only;

* the fishermen obtain the necessary bank credit for boats and nets to replace the loans traditionally provided by the middlemen; (The Bangladesh Krishi Bank was to provide necessary credit for fishing equipment for the licensed fishermen at all the sites to be managed by the Department of Fisheries.)

* fishing is conducted in accordance with rules designed to encourage conservation, and where possible, restocking;

* the fishermen receive a fair price for their catch; and,

* sufficient funds are levied from the fishermen to enable the Department to cover the costs of licensing and make whatever capital investment might be necessary to improve the longer-term productivity of the selected *jalmahals*.

In a further three of these 12 *jalmahals*, non-governmental organizations (NGO's) were to be involved in working with fishermen. The NGOs organize and support groups of fishermen in a variety of ways, including credit, designed to meet the objectives of the government's new open-water fisheries management policy. Unfortunately, in the event, fishermen were not licensed in the three *jalmahals* designated for NGO management, so this part of the experiment could not be fully evaluated.

The MOFL has undertaken this project in order to devise and test the most effective ways to implement an open-water fishery policy countrywide. As I understand it, the policy would have three objectives:

First, to gradually eliminate the old short-term leasing system in about 5-10 years' time;

Second, to save the fishermen from exploitation by influential middlemen; and,

Third, to increase fish production through proper conservation of fisheries resources and adopting measures of biological management.

The first and second objectives are being sought through the introduction of a licensing system for genuine fishermen living in the neighborhood of the *jalmahal*. Licensing is to be to groups of fishermen sharing common equipment. Licensing would eliminate the former "middleman" leaseholder, with revenue realized from the lease being recovered through license fees. Other opportunities for exploitation of fishermen through the credit and marketing systems however remain.

Realizing the third objective -- conservation of fisheries -- is more problematic and long term. Conservation of fish stocks is in part a function of fishing pressure. The present licensing system and enforcement machinery seem unlikely to prevent overfishing by the licensees or entry by unlicensed persons. Management for sustained yield appears to depend on a greatly enhanced sense of security of tenure by stable fishermen's groups, backed up by technical advice from DOF field staff.

In closing, I am pleased to note that the Workshop will focus not only on technical constraints but on issues of access to and management of the *jalmahals*. In my view, there are two particularly important questions in fisheries management which I believe should receive a prominent place in the workshop deliberations.

These two questions are:

First, how can the government best assist genuine fishermen to organize, and stay organized, so that they can secure credit and access to advantageous markets? By genuine fishermen I mean persons who are directly engaged in the capture of fish in open waters and who earn a significant proportion of their annual income from this source.

The second question is, how can fishing pressure be managed so as to protect breeding stocks and improve production from Bangladesh's inland fisheries? The answer to this question, it seems to me, turns on how best to ensure security of tenure. By security of tenure I mean multi-year agreements and the capacity to exclude fishermen who are not party to the agreement.

These are key questions; I trust the collective wisdom of the participants in this workshop will yield practical answers to them.

Thank you very much.

Guest's Address

Dr. Quamrul Islam
Chairman
Bangladesh Matshyajibi Samity
(National Fishermen Association)

Aassalamu alaikum, Honorable Minister, Ladies and Gentlemen.

In Bangladesh, 6% of the Gross National Income and 15% of the total export earnings come from fisheries. About one-tenth of the total population of the country are engaged, directly and indirectly in fishing and related activities. After the downfall of price of jute in the world market, fishery has assumed a bigger role in the economy of the country. According to 1984 fishery survey of Bangladesh, there are 4,268,740 hectares of inland water areas. Out of this, 94.8% are occupied by inland open-water bodies (river, *haors*, *beels*, *baors*, lakes, flood plains, etc.) while the rest by closed waters (ponds and areas of coastal aquaculture). Besides, there are 1,166 square kilometers of marine fisheries areas along the coasts. Of the total fish production of the country, 61% come from the inland openwaters, 16% from inland closed waters and the rest from the coastal marine waters.

Evolution of the Socio-economics of Fishermen

In the past, there were a small population but ample resources. Especially, those who fished in the rivers and riverine waters were economically better-off than those who worked in the agriculture and other sectors. During those days, fishing was considered a low-caste job and there was no attraction to other occupational groups towards fishing. As such, the traditional fishermen community enjoyed absolute communal right to fishing and enjoyed better economy due to abundance of resources relative to the size of their population.

During the *zamindari* system under the British rule, the fishermen could fish freely in all open-waters in exchange of a nominal *nazarana* or tax to the *zamindars*. After the abolition of the *zamindari* system, especially in the 1960s when the leasing system became fully operational, the life and livelihood of the traditional fishermen started to become harder. In the name of lease-management, a group of rural elite and middlemen profit seekers started to exploit the fishermen. On the other hand, increasing landlessness, population growth, loss of land in the rivers due to erosion, lack of employment opportunities in the agriculture and urban industrial sector, etc. have, over the years, made many of the non-fishermen population take up fishing as their only means of livelihood. As a result, the size of fishing dependent population grew rapidly while the fisheries resources were reduced due to natural and artificial causes like massive siltation of the rivers, loss of water areas and fish habitat due to construction

of embankments, flood control and irrigation projects, use of fertilizers and insecticides in the agricultural fields and discharges of poisonous industrial wastes in the open-waters, etc.

Governments, in the past, did not take appropriate measures to protect fisheries from destruction. In fact, some of the steps taken by previous governments were counter-productive and against the interest of the fishermen and fishing communities. No opposition came from fisheries scientists, experts and bureaucrats to the government moves of leasing out fisheries to associations of youths, women, unemployed and handicapped freedom fighters, instead of leasing it to the fishermen communities. It was *Jatiya Matshyajibi Samity* (National Fishermen Association) that opposed that kind of move.

Leasing System and the Introduction of NFMP

Although, the *zamindari* system was abolished in 1950, its actual implementation started in the 1960s. The then Governor of East Pakistan, Mr. Azam Khan started the movement of organizing the fishermen into cooperatives and introduced the lease of the fisheries to the cooperatives including training of cooperators. On the whole, the fishermen were better off during the Pakistan period (1947-1971). Unfortunately, after the liberation of the country, *lakhs* of Taka and goods, allocated for the reconstruction and rehabilitation of the fishermen communities, did not reach them. Instead, the organizers and leaders of the Fishermen Cooperatives, who were non-fishermen, made their fortunes with those relief money and goods. The situation today in 1989, is not any different.

In 1973, with the initiative of the Fisheries Minister of that time, the late Mr. Sherniabat, and through cooperation of *Jatiya Matshyajibi Samity* the government declared the provision of granting the fishing rights in the *jalmahals* to the actual fishermen in consultation with the genuine fishermen cooperatives every year with an annual increase of rent by 10% from the average value of lease during the past three years. Later, in 1976, the government abandoned this provision and declared the provision of limiting the leasing system only within the fishermen cooperatives. With this provision in force, thousands of fake fishermen-cooperatives were created under the influence of the so-called *ijaradars*, *jotdars* and wealthy people and the lease of the *jalmahal* continued to be purchased by these non-fishermen groups all over the country. This created a situation of competition among wealthy people, thereby increasing the auction or lease value of the *jalmahals*, as well as a system of illegal sub-leasing for a price many times higher than the original lease payment to the government. The sub-lessee started charging higher tolls to the fishermen and induced over fishing in most of the open-waters of the country. In consequence, the fisheries resources started to decline and suffering of the fishermen increased.

In 1980, the government made a review of the situation and, considering the need for increasing fish production in the country as well as the economic well-being of the fishing community, decided to transfer the responsibility of the lease-management and administration of *jalmahals* to the Ministry

of Fisheries and Livestock (MOFL). Unfortunately, the Department of Fisheries (DOF) did not have even one fourth of the manpower to administer the management responsibility in the thousands of *jalmahals* scattered all over the country. On the other hand, vested-interest, political powers together with dishonest officials in the Ministry of Lands conspired against this move and created a situation of massive litigation cases against the leases administered by the DOF. As a result, collection of revenue were greatly hampered and the government again transferred the *jalmahals* to the responsibility of the Ministry of Lands.

Nevertheless, the recommendations made by the government's land reform commission emphasized that the objective of the government is not to maximize revenue from fisheries but to improve the economic condition of the genuine fishermen. Given the failure of previous attempts to properly manage the *jalmahals* and keeping in mind the need for improving the socio-economic conditions of the fishermen and increasing the fish production of the country in the light of the recommendations made by the land reform commission, the then Fisheries and Livestock Minister Mr. Sirajul Hossain Khan discussed the issue with the Bangladesh *Jatiya Matshyajibi Samity*. Thus, through the active initiation of the Minister, our President General Hossain Muhammad Ershad made a declaration of the New Fisheries Management Policy (NFMP) on 12 March, 1986 at the convention of the *Jatiya Matshyajibi Samity*, and later on August 19, 1986 made the inauguration of the new policy in Mohasing river of Sunamgonj.

Deterioration in the Fisheries Resources and Condition of Fishermen

The water environments of Bangladesh are very much conducive for the fisheries resources due to the favourable climatic and natural conditions. According to reports by The World Bank and fisheries experts, with proper management of the fisheries, the country could produce enough fish to meet the protein needs of the country as well as to earn more foreign exchange than that obtained by exporting jute at the present time.

However, several factors have caused a decline of the fish production from the open waters in recent times. Important among them are: indiscriminate fishing practices, use of chemicals and insecticides in the paddy fields, reclamation of lands for agriculture, destruction of mangroves and other fish habitats, unplanned construction of embankments, flood control and irrigation projects and siltation of the rivers. Since the traditional fishermen are engaged in fishing in the open waters, the decline in the fisheries resources has become a threat to their livelihoods.

On the other hand, fishing from the open waters require substantial amount of investment in gear, boat and other equipments. In the past, the fishermen were able to secure the needed capital from their fishing income. Now, due to the decline of resources, the income of the fishermen is not enough to invest on capital equipments for continued fishing. As a result, they have to go either to the moneylenders who charges a high rate of interest for the borrowed funds, or to the *aratdars* for cash advance

in order to finance their capital needs. Thus, the traditional fishermen became heavily dependent (and eventually exploited) by the money lenders and middlemen.

With the declaration of the NFMP, the government created a silent revolution that would put the misery of the fishermen to an end. The features of the new policy are:

* the abolition of lease-system in five to ten years;

* ensuring of the fishing rights of the traditional fishermen through licensing;

* . freeing of the fishermen from the exploitation of the middlemen and leaseholders, rather than increasing the revenue earning of the government; and

* conservation and regulation of fisheries for increased and sustained production.

Unfortunately, there are still vested interest group who want to sabotage the NFMP. We understand that there are differences of opinions regarding the strategy and approach toward the implementation of the NFMP. But, we also believe that with honest intention to go forward with this revolutionary approach to management, the concerned ministries, departments, agencies including MOFL, Ministry of Lands and the *Jatiya Matshyajibi Samity* can work out a practical solution to these.

To conclude, I must say that the fishermen themselves must come forward to cooperate with the government agencies and make the NFMP a success. Otherwise, it will also fail like other welfare policies adopted in the past.

Thank you.

Special Guest's Address

Mr. Mokammel Haq
Secretary
Ministry of Lands
Government of the People's Republic of Bangladesh

The Honorable Minister *Janab* Sardar Amjad Hossain, the Chairman of this session, my colleague who is absent due to unavoidable reason the Secretary, Ministry of Fisheries, and his able Deputy, the Joint Secretary, Dr. Bailey, the Representative of The Ford Foundation, the Representative of the International Center for Living Aquatic Resources Management (ICLARM), Ladies and Gentlemen.

I would like to thank the organizers for inviting us to this particular seminar which we believe in the Ministry of Lands is a very timely one. Really it is an extremely timely occasion to hold this seminar and we specially thank the Ministry of Fisheries and Livestock (MOFL), The Ford Foundation and ICLARM particularly for organizing this workshop. I would like to make a few comments which would be partly formal and partly informal but which I hope would be helpful for the organizers of this seminar.

The *jalmahals* or the water bodies in Bangladesh, we all know, are the largest fresh water fish producing area. The experts will give much more details, but in our sojourn through official and unofficial duties, we have seen how they have been able to sustain a very large number of people in Bangladesh in various ways.

The Chairman of the *Jatiya Matshyajibi Samity*, our Dr. Quamrul Islam, has referred to some of the Socio-Economic background of the fishery bodies and also the problems of the fishermen. Fishing has traditionally being done by those who are fishermen by caste and by social classes. Along with the birth of two nations, one in 1947 (creation of Pakistan) the other in 1971, (the country of Bangladesh) certain social, economic and sociological forces have broken down the old barriers and therefore, it is no longer a very undignified way of earning a living if someone fishes and makes a living out of it or derives income from it. Previously most of the fisheries were owned by the *zamindars* who used to sub-lease their fisheries or make earnings out of them. But subsequently, when the *zamindari* was abolished, the rights over these fisheries as well as the various *hats* and *bazars* devolved on the government in the Ministry of Lands. That is how we (Ministry of Lands) have become, shall we say, rather unwilling owners and managers.

To begin with, the Ministry of Lands did not have much of a management system either in the field or at the Headquarters. The problems were multiplied by the abolition of the Board of Revenue which used to look after the *jalmahals*, to some extent, when Bangladesh came into being. These matters are slightly peripheral but very very important to what we are going to discuss. The fisheable water bodies below 20 acres have been given by government decision in 1984 to the *Upazila Parishads*. By subsequent order water bodies with a size of 3 acres or and/or generating five thousand Taka or less per year will be given for public use by the general public and the people all around could fish there with payment of a token, I suppose one Taka or something like that, which will be managed by local bodies as well as the Revenue Officials.

What I am trying to say is this, that when the fisheries were transferred in 1980 to the Ministry of Fisheries for management purposes which Dr. Quamrul Islam has erlier mentioned in his speech, there was tremendous amount of production and income generations. But subsequently the government in their wisdom, or lack of it decided in 1983 based on the recommendations of the Land Reform Committee's findings and recommendations that, it was better that the management of the fisheries should revert back to the Ministry of Lands and they also gave some guidelines how these fisheries should be dealt with. But the important point they made in Land Reforms Committee about fisheries is that attempt should be made to see to it that the real fishermen should get the benefit out of this fisheries. Now the question and the problem arises with the word "real" because in our country people come as dapper as can be, all suited, booted and what else, and they claim that they are "landless" people. They probably are. But when you ask them "are you assetless people", they cannot give an honest answer. We Bangladeshis have to strive hard to survive and that survival instinct has led us to definitional problems. We all think we are "real" people that creates problems because in any other society simply saying "fisherman" is adequate. Why is it that in Bangladesh we have to add the word "real"? Everywhere else, a fisherman is a fisherman and a non-fisherman is a non-fisherman. But here we have to constantly add the word "real" to fisherman, which means there are some "un-real" fishermen; and who are they? And how this thing could be sorted out? Therefore, this is a very important task of finding out the "real" fishermen.

I was talking to the Chairman that I wish we were asked to comment, to write papers, to deliberate and participate, in this seminar more directly which some how I suppose has not taken place but in any case we will ask our people to attend and to listen, so that we could also benefit from all deliberations. I would like to point out to this session, the opening session, that the government has decided in the Ministry of Lands to implement land reforms with the following objectives: (a) to optimize production from lands, and land in fact in law includes water, therefore, water is an integral part of the land reform issue in the country; (b) that the growth rate of agricultural production, and here agriculture would also include pisciculture and fishery, all the reform measures should strive for increasing

the growth rate in agriculture, fisheries and other matters related to land; (c) that the objective of land reforms is to improve the mobilization of domestic resources through government's earning in lands and waters. When I said lands, legally and definitionally it includes water and water bodies and (d) that the government is determined to establish a modern, suited to the time, efficient and less corrupt land management system. The last one is the first requirement because without a good management system the other three objectives cannot be achieved.

Mr. Chairman, you are all aware that the government has set up a series of institutional mechanisms which begins at the appex with the National Land Reforms Council, headed by the President himself which deals with all matters including matters of fisheries. We have set up a District Committee which is a broad based committee where the Deputy Commissioner is the Chairman of the District Land Reforms Implementation Task Force, and it includes District Fishery Officers and Rural Development Officer and many other officers; I do not wish to go into details. In the *upazila* there is an *Upazila* Land Reforms Committee headed by the *Upazila Nirbahi* Officer. It is also broad based multi-disciplinary and multi-organizational where the NGOs and the representatives from various other interest groups and women are represented. We have tried to see that these things do reflect the requirement of the people and of the time. We also know that the government have set up a Land Reforms Board which is going to be functional soon and the Land Reforms Board will look at the aspect of the management of land reforms. It will go down right upto the *upazila* and beyond that, up to the Union level. We are removing the name *tashil* and *tashildar* and making it as Union Land Office, *Upazila* Land Office, District Land Office and so on and so forth we want to get away from the *zamindars'* definition of his office as *Tashil* Office, which meant the collection of Revenue as the main aspect of the job that is not the government's main aspect of the job any more.

Coming back to the problem of fisheries, the government in the Ministry of Lands is also seriously considering the New Fisheries Management Policy (NFMP), which has already been implemented on 150 *jalmahals*. There have been experiments on NFMP by the MOFL on which deliberation have to take place. We all hope that it succeeds. We also hope that if there are inadequacies, if there are problems and if things are not happening positively, these things should not be whitewashed and they should not be shoved under the carpet. We should not say that things are alright while they are not.

We are striving at a better management system as I said about our own system in the Ministry of Lands that we are trying for a less corrupt land management system. I am saying it as the permanent head of the ministry, as the Secretary of the Ministry of Lands because our system is not only fairly corrupt, it's heavily corrupt, we are making attempts and we are making arrangements by institutional systems through which we can bring a better system into operation. To begin with we have

taken up to *upazila* an Assistant Commissioner of Land who is a young and educated man, has some principles and scruples, and some ideas. We are trying to completely remodel our management system of Land at the same time as I said we are thinking seriously about the fisheries management policy.

We have the government considering setting up the *chingri mohol*, which means the *shrimp mohol*. Because, out of shrimps we estimate that between 40 to 80 crore of Taka the government could get if it could be managed properly. Government would have to get proper type of people, proper experts because it has to be managed properly. Because people are paying 1,500 Taka for an acre of shrimp land to us very happily, that means the return is very high whereas we get 3 Taka per acre of agricultural land. These are issues which government is considering and as I said on fishing matters also we are extremely concerned. We are preparing a series of policy papers on these matters and we hope that the outcome of this seminar would help us in reshaping our policy issues in a positive manner. We must believe and act in a way that the ultimate aim of all governmental functions or societal functions is the well being of the people in general. We should not simply think in terms of this Ministry or that Ministry or this Department or that Department whether NGO is good or better or bad, whether NGOs should cooperate with the government. There are lots of debates and we had to face criticism; that's why we are so friendly to them. But those which are good ones we should definitely be friendly with them. We will work hand in hand with those who are good.

I have taken a lot of time but I felt that probably it will be helpful for the discussants of this seminar to have a background of what is happening and what is proposed to be happening in the Ministry of Lands in so far as the fisheries are concerned, we are even considering of setting up a *matshya gram* like the clustered villages for the landless. In fact one of our Deputy Commissioner, one of our Collector has set up one or two *matshya grams*. Calling it "fisherman village" is not an adequate expression. Whatever it is the "real" fishermen, as we defined, should be there and they should enjoy the products of that particular water body. The government has in their programme for clustered villages that the government ponds and tanks shall be given to landless fishermen.

I do not believe that in Bangladesh it is any more true that there are simply one kind of people who fish and do nothing else. There are people who fish for sometime or part of the year and cultivate for part of the year and do some other kind of non-agricultural occupation. He might be even carrying loads, he might be plying a boat, he might be pulling a rickshaw but part of the year he might be fishing. So it's a question of people who are doing several occupations during the year. We are trying to get many of them around small ponds and tanks and settle a particular water body with a group of people. The people shall be provided Bank and other loans, and institutional supports so that they

could produce fish: they could probably produce some ducks also and do certain other vegetable growing and other things. They will be living on the banks of ponds. That's the idea because otherwise they won't be able to protect their produce and they won't be able to look after them. So there are thoughts and I do wish these thoughts do converge and these thoughts do coalesce because finally the Nation should have one policy relating to fisheries which should be in the interest of the fisherman at one end and other kinds of people who are also involved or attached to fisheries at the various other levels. With these words I would like to thank you very, very much and I apologize for taking a long time but I thought that this might be helpful for this seminar and during its discussion.

Thank you very much.

Inaugural Speech

Mr. Sardar Amjad Hossain

Honourable Minister
Ministry of Fisheries and Livestock
Government of the People's Republic of Bangladesh

Mr. Chairman, special guest, experts and officials participating in the Workshop, ladies and gentlemen; Aassalamu Alaikum.

Fish is a valuable natural resource of Bangladesh and it contributes significantly to the national economy. In Bangladesh, 80% of the animal protein comes from fish and more than ten million people are directly or indirectly dependent on fishing, fish processing and its marketing. Of them, about one million people are full-time professional fishermen and the rest are either part-timers or subsistence fishermen. Besides, being the main source of animal protein-supply in the country, fish earned about Taka 4,600 million during the last fiscal year through export. Therefore, it is our duty and responsibility to take measures for the best possible utilization of this natural resource through proper management of fisheries with the ultimate objective of strengthening the economic base of the country.

I am glad to learn that with this purpose in view, the Department of Fisheries (DOF) of the government of Bangladesh in collaboration with the International Center for Living Aquatic Resources Management (ICLARM) and The Ford Foundation has arranged this 2-day workshop on "Experiments in New Approaches to the Improved Management of Open-water Fisheries in Bangladesh".

The fisheries sector in Bangladesh has been neglected for ages. Modern management techniques and technology were absent in this sector. The fishermen are poor, hardly possess a small boat and a small net. Even in the recent past, they did not know about fishing in the sea. Increase of fish wealth through culture was also unknown to them.

After independence, steps were taken to identify some untapped areas in fisheries sector for development to meet the increasing demand of food through application of modern technology. As a result, sea fishing became popular and is contributing substantially to the national economy. In spite of the application of the modern technology and the identification of unknown fields in marine fisheries sector, the socio-economic condition of the real fishermen did not improve. They cannot make the necessary investment due to poverty. Moreover, they are under financial bondage of the middlemen money lenders. The present government under the leadership of President Hussain Mohammad Ershad, is anxious about the plight of the fishermen and is determined to improve their condition.

Government owned fisheries (locally known as *jalmahal*, *sariatmohal*, *jalkar*, etc.) are the main source of fish supplies in the country. There are 10,000 government owned *jalmahals*, canals, *haors*, *baors*, *beels*, etc. and 100,000 tanks and ponds. Government owned *jalmahals* are under the control of the Ministry of Lands. The number of private tanks and ponds will be about 1,700,000. Majority of the private tanks are lying derelict. It is necessary to explore the possibility of culturing fish in those tanks through lease under the Tank Improvement Act.

The per acre yield of fish in open water is only 43 kg/year. The prospect of increasing the production is bright. Fish production may be remarkably increased through proper management of fisheries and application of modern technology. The best possible use of the water bodies for development of fisheries is not possible due to lack of training and research for want of necessary inputs and also because of the problems relating to ownership and management of water bodies.

Now, the responsibility of managing the government *jalmahals* of area over 1.22 hectares (3 acres) and below 8.14 hectares (20 acres) lies with the *Upazila Parishads*. The Ministry of Lands is directly vested with the responsibility for management of water bodies of area over 8.21 hectares. Various disputes have arisen about the water bodies which are managed by the *Upazila Parishad*. The *Upazila* Fishery Officers are not being able to apply their knowledge and experience in fisheries development. The water bodies are given lease to the highest bidders through public auction. Under this arrangement the middlemen, money lenders and the lessees are given the responsibilities of management of water bodies. Now, the fishermen-community is being organized. But their financial condition is not good and they do not get the responsibility of managing water bodies through participation in auction. Though they are participating directly in catching fish, they are not getting the ownership of the fish harvested. They are not getting the *jalmahals* even though they are real fishermen. They work as mere day labourers. From past experiences, it seems that the highest bidders of the *jalmahals* are not at all interested in proper management and conservation of fisheries. They, very often, harm the fish wealth by violating the Fish Act. Increase of revenue earning should not be the main purpose of fisheries management, rather the water areas should be utilized for the upliftment of the poor fishermen communities. This will improve the economic condition of the fishermen in one side and increase the fish wealth on the other. They will conserve the fish wealth for their own interest.

Realizing the problems of the fishermen-community the present government decided to introduce the New Fisheries Management Policy (NFMP) in 1986 to replace the leasing system. Through the introduction of the new policy, the fishermen-communities can be directly engaged in management of the fisheries and catching of fish. The only slogan of the new policy will be "*Jal jar jala tar*". (He who has the net is the owner of the water body).

Through this arrangement, it will be possible to eradicate the middlemen lessees. The real fishermen families are to be identified in order to ensure the interests and demands of the fishermen. Investment of money is necessary to develop the water areas for increasing fish. Banks and other money lending organizations will have to play a vital role in this regard. They will have to be given loans on soft terms, if possible, without any collateral. But it should be ensured that the loans are properly used. All information with regard to granting loans to the real fishermen are to be maintained properly. At present, there are various opponent organizations to the fishermen-community. In this case, all concerned are to work with a sense of compromise. The interested quarters may create impediments in the implementation of the government policy, *"Jal jar jala tar"*. We shall have to be alert about their role.

Experts from home and abroad and the senior officials are participating in the workshop entitled "Experiments in New Approaches to the Improved Management of Open-water Fisheries in Bangladesh". Through their mutual discussions and exchange of views, the problems of the management of fisheries of our country will be identified. Through solving those problems, they will recommend measures for best possible use of the water bodies and also to protect the interest of the fishermen-communities. Their recommendations will help the government in making policies in this field. I offer my sincere thanks to the DOF, Government of Bangladesh, The Ford Foundation and ICLARM for arranging this workshop.

I declare the workshop open and wish its successful completion.

Khoda Hafez.

Bangladesh Zindabad.

Senior Chairman's Address

Mr. Md. Ahsan Ali Sarkar
Joint Secretary
Ministry of Fisheries & Livestock
Government of the People's Republic of Bangladesh

Honorable Chief Guest-Minister for Fisheries and Livestock, Special Guest-Secretary of the Ministry of Lands, distinguished guests, delegates and participants.

I deem it a great privilege to say a few words at the inaugural session of the workshop on "Experiments in New Approaches to the Improved Management of Open-water Fisheries in Bangladesh". I thank the organizers of the workshop for giving me the opportunity to speak to you. The importance of the fisheries sub-sector in Bangladesh in terms of nutrition, income, employment and foreign exchange earning is significant. Fish supplies 49% of annual consumption of Protein, contributes 3.5% of the Gross Domestic Product (GDP) and accounts for 12% of the total export earnings of the country. Besides a large number of people depend on fisheries as their primary source of income and employment. About 8% of the population depends on fisheries for their livelihood. There are about 1.2 million commercial fishermen of which 60% are inland and 40% are marine. Out of total employment of about 28 million in Bangladesh, approximately 7% is in the fisheries sub-sector. Given a relatively low average capital/labour ratio, the fisheries sub-sector has substantial scope for employment generation and hence can contribute to poverty alleviation. But until recently this sub-sector did not receive adequate attention of the government in terms of resource allocation, institutional development, financial discipline, and policy reform. However, the present government, considering the importance of this sub-sector in the national economy, has taken a timely step in formulating the New Fisheries Management Policy (NFMP).

Jalmahals or fishing grounds or water bodies constitute the important source of fresh water fish production in the country. These *jalmahals* are leased out by the Ministry of Lands through auction. From our experience, we have seen that leases are usually obtained by middlemen belonging to the rural power elites who through their monopolistic control exploit the fishermen. They charge exorbitant rents apart from taking away the bigger share of the catch from the fishermen. The existing system of management also tends to encourage over-fishing as both the fishermen and lessees are motivated by desire to maximize profits. In this system, enforcement of fish protection and conservation measures also become difficult. Appreciating this problem, the government has embarked upon a new management system on experimental basis. The new management policy, among others, has provided for direct licensing in place of leasing in selected *jalmahals*, thereby eliminating the middlemen. It has also provided for credit support for fishermen from

designated banks. In the last two years of operation, the policy has been evaluated by the Bangladesh Centre for Advanced Studies (BCAS) and the Implementation, Monitoring and Evaluation Division (IMED). The evaluation report suggests a number of constraints that stand in the way of effective implementation of the *jalmahal* policy. Interference by middlemen, unlicensed fishermen and influential traders has created problems for the genuine fishermen. The various *upazila* and district committees also have not done much work towards production, distribution, marketing, extension and training in fisheries. The report, however, finds licensing policy pro-fishermen, but identifies the real problem with the dominance of anti-productive forces and rural and urban elites.

This, however, has to be dealt with in the larger context of the socioeconomic problems of the country. But so long as the fisheries sector is concerned, the government's policy to eliminate the middlemen has started to yield some modest results. The two other objectives of the policy are, to ensure fishing rights of the genuine fishermen, and to conserve and nurture the fishery resources of the country.

Fishery policy of Bangladesh has been guided by the dual aim of increasing foreign exchange earnings through coastal shrimp culture, and increasing income, employment and nutrition from flood plain fishing. A steady growth in these two sectors can be observed over the last few years. But there are still a number of bottlenecks that prevent full scale development in the fishery sector. I hope the workshop will concentrate on all these problems and issues.

The initial constraints had been identified by the planners of the *jalmahal* policy as the limited organizational strength of Department of Fisheries (DOF) as well as the administrative problem of securing the immediate control of hundreds of different water bodies lying under different authorities. There is also the lack of a well planned management programme which requires necessary legal framework and the needed cooperation and collaboration from other bodies. In addition to these, if we analyze the reasons for shortfall in fish production, we come across both institutional and social factors. The major difficulties can be summarized as lack of knowledge about proper culture techniques, inadequate fishery extension programmes, withdrawal of surface water for irrigation, construction of unplanned embankments and water control structures, silting of rivers and the absence of a national policy for use of these valuable natural resources for different competing users. It was only towards the end of the plan period that fisheries came to be recognized as an integral part of water sector development projects. It is not only irrigation and water control structures which have bearing on fisheries, but the use of chemicals in agricultural production and industrial wastes adversely affect fish population. Lack of knowledge about the ecology and natural habitat of major fish species in Bangladesh has accentuated this problem of ecological degradation. A Water Sector Master Plan (MPO) which is addressing this problem of coordinated approach to water use is expected to have positive effect on fisheries development in future.

The experience during the last two years has made it clear that the success of the NFMP will require the active participation of the other Ministries and Departments of the government in the administration and management of the fisheries. As we all recognize, the management of our fisheries concerns both people and resources. This requires adequate administrative support, infrastructure and capital. Thus, the role of banking sector in supplementing the capital needs of the fishermen is equally important as the roles of the government agencies like Ministry of Lands, Department of Cooperatives and Local Government at the *upazila* level to implement the NFMP.

I hope that during the course of this workshop, ideas and experiences on fisheries will be discussed and a clear conclusion will emerge with regard to the successful implementation of the NFMP in our greater national interest.

Thank you.

Inland Water Fisheries in Bangladesh: Management Options and National Interventions[a]

Max Agüero
International Center for Living Aquatic Resources Management (ICLARM)
MC PO Box 1501
Makati, Metro Manila
Philippines

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Abstract

A review of the basic characteristics of inland water fisheries in Bangladesh is made to provide a background for the analysis of the main issues, problems and rationale of the New Management Policy for Inland Open-water Fisheries in Bangladesh. The socioeconomic importance of inland fisheries is highlighted and the main management problems are analyzed. The new Government strategy for licensing fishing access is discussed and guidelines for discussion during the Workshop are proposed.

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a ICLARM Contribution No. 546.

Introduction

Inland fisheries in Bangladesh present several unique characteristics and complexities which make their management very difficult but also very interesting for those involved in fishery management and research.

In the following sections, a brief analysis of the main issues and problems of inland water fisheries in Bangladesh will be discussed with the purpose of providing a background and rationale to the ongoing government attempts to solve these problems. Also, steps taken to improve the performance of government interventions by means of an innovative experimental management approach will be presented. Finally, the main areas of analysis which need careful consideration in the management of inland water fisheries of Bangladesh will be identified in order to provide additional background for the other contributions in these proceedings.

Basic Characteristics of Inland Water Fisheries

The current estimated yearly production of Bangladesh is approximately 815,000 tonnes (t) of fish from both inland and marine waters. About 53% originate from traditional fishing in large inland freshwater bodies like natural depressions, lakes, rivers and their associated flood plains, while the rest is contributed by inland aquaculture (20%) and marine capture fisheries (27%) (DOF 1988) (see Table 1 and Fig. 1).

Table 1. Sector-wise estimated annual fish catch of Bangladesh, 1983-1987.[a]

Sector of Fisheries	Water area[a] (ha)	Annual Catch (t) 1983-84[a]	1984-85[a]	1985-86[a]	1986-87[b]
A. Inland Water					
(a) Capture					
1. River and estuaries (except Sundarban area)	1,031,563	207,766	213,057	199,600	195,177
2. Sundarban		7,783	6,825	7,112	5,975
3. Beels	114,161	51,373	45,893	45,258	42,077
4. Kaptai lake	68,800	4,057	2,700	2,433	3,981
5. Floodlands	2,832,792	200,616	194,130	187,396	183,796
Capture Total	4,047,316	471,595	462,605	441,799	431,006
(b) Culture					
1. Ponds	146,890	107,944	111,567	123,804	142,876
2. Baors	5,488	862	962	968	1,174
3. Shrimp farms	87,300	8,219	11,282	19,951	22,050
Culture Total	239,678	117,025	123,811	144,723	166,100
Inland Total	4,286,994	588,620	586,416	586,522	597,106
B. Marine					
1. Industrial fisheries (trawl)		14,500	12,440	11,898	12,356
2. Small-scale fisheries		150,382	175,123	195,503	205,223
Marine Total		164,882	187,563	207,401	217,579
Country Total		753,502	773,979	793,923	814,685

a) DOF (1986).
b) DOF, unpublished data.

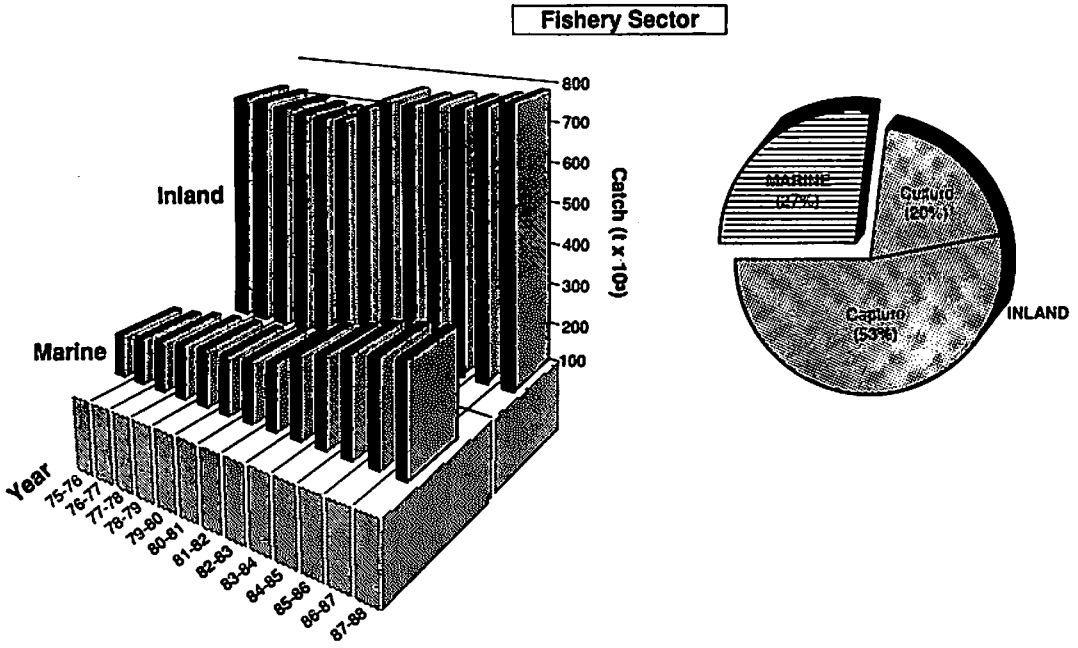

Fig. 1. Catch composition of fisheries in Bangladesh by sector.

Thus, over half a million tonnes are generated by freshwater fishery resources. Only China, India and the USSR produce more freshwater fish than Bangladesh.

The country presents a typical flood plain system with a warm sub-tropical monsoon climate and frequent heavy rains, floods, typhoons, and occasional tidal waves. The total land area is approximately 144,000 square kilometers (km^2), while water bodies cover about 4.3 million hectares (ha).

The inland fishery resources in Bangladesh are distributed over 15,000 km^2 of perennial inland waters with a total of about 24,000 kilometers (km) of rivers, canals and their tributaries, 1.8 million ponds, and numerous natural and artificial lakes (*baors*[a] or oxbow lakes). In addition, about 28,000 km^2 of flood plain support seasonal fishing during the monsoon months (DOF 1986).

The rivers are part of the Ganges, Brahmaputra and Jamuna river systems of Himalayan origin, flowing through Nepal, India and Bangladesh, and emptying into the Bay of Bengal (see map p. vii). In Bangladesh, the three principal rivers, known as Padma, Meghna and Jamuna-Brahmaputra, and their tributaries constitute about 71% of the inland perennial waters (see Table 1). These rivers drain huge amount of waters originating from melting snow, and monsoon rains, causing inundation of vast areas of the plains on both sides of the rivers. This introduces seasonal flood plain fishing extended to an area of about 28,000 km^2.[b] The stream flow in the entire country totally outflowing to the Bay of Bengal, fluctuates between approximately 100,000 m^3/s in August to 1,000 m^3/s in February, of which 90% inflow to Bangladesh comes from India. (Shahjahan 1988).

a See Glossary of Bengali Terms, Appendix 1, p. 138.

b In 1988, the flood waters reached approximately 122,000 km^2 or 84% of the national territory and directly affected 45 million people (Bashar 1988).

In addition, due to the strength of flow of waters and deposition of sediments that are being carried by these waters, especially in the southwestern parts of the country, the rivers change their course, leaving behind flowless ox-bow bends that are cut-off from the main water channels. There are about 5,000 ha of such stagnant water bodies in the southwestern parts of the country known as dead rivers, *baors* or ox-bow lakes.

Again, within the flood plains there are low lying areas, called *haors* including some deeper pockets within them, which form a major constituent of perennial water bodies in Bangladesh. This type of water body covering an area of 114,000 ha is common in the basins of Sylhet-Mymensingh, Rajshahi and Faridpur.

The other distinct open-water fishery environment in the country is Kaptai Lake formed by the creation of an artificial dam across the river Karnafuli in Chittagong in the southeastern part of the country.

The ecosystem composed of rivers, lakes, ponds, reservoirs, *haors*, *beels*, and marshy areas, together with the overall geographic location, climate and ecological conditions, produces in Bangladesh one of the richest inland fisheries and largest flood plains in the world with more than 200 different species of fish[a] which provide about 75% of the total production of aquatic resources of the country (Aguero 1986). The single most important species exploited is hilsa, constituting approximately 44% of the riverine catch (DOF 1987), followed in importance by freshwater prawns, carps and catfish.

The hilsa is largely an anadromous species distributed in the foreshore areas, estuaries and freshwater rivers of the western division of the Indo-Pacific faunistic region (Raja 1985; Islam 1989; see also Y. Ali this vol.). Of the three countries (Bangladesh, Burma and India) in the upper Bay of Bengal region, Bangladesh secures the largest share of the landings with about 150,000 t per annum. The total landings in India and Burma are roughly 30,000 t/year (Raja 1985). In Bangladesh especially in the rivers, the fishery is dominated by the artisanal sector with traditional non-mechanized boats and a variety of gears, although the major contribution comes from gill net/drift net (Melvin 1984; Raja 1985).

Although Bangladesh is very small in terms of land, the human population is over 100 million persons resulting in a mean density of about 740 persons per square kilometer, placing Bangladesh among the most densely populated countries. The scarcity of land and space becomes even worse during the monsoon period (June to October) when the heavy rainfall and huge amounts of water carried by rivers from the Himalayas, submerge a further two thirds more of the cultivable land and when approximately one third of the entire country is beneath floodwaters of up to 5 meters (m) deep.

On the other hand, the diversity of water bodies, geographical configuration and location make Bangladesh very appropriate for the production of fish by means of culture systems. Rough estimates by the FAO and World Bank indicate that through culture-based fisheries and efficient use of the wide variety of water bodies, it would be possible to obtain an increased production of about 300,000 to 330,000 t/year; fish farming is estimated to be able to yield an additional 120,000 t/year (FAO 1985).

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a See List of Important Fish and Prawns, Appendix 3, p. 142.

The Socioeconomic Importance of Inland Waters

Fisheries in Bangladesh are the most important source of animal protein (80% of the total protein intake is provided by fisheries produce), generating foreign exchange, and offering good potentials for improved production and economic welfare. Fisheries provide also full-time employment to over 1.2 million people and approximately ten million more are estimated to be involved in fishery-related activities on part-time basis (FAO 1985). Shrimp exports provide nearly 9% of the value of total national exports. Because of the rich riverine system throughout the country, the seasonal flooding pattern and the limited road infrastructure, water bodies provide one of the most important and efficient pathways for transportation of both people and goods.

Finally, large portions of the submergible areas become very productive land for rice during the off-flooding period, allowing the production of approximately 14 million tonnes of rice a year.

Management Problems of Inland Water Fisheries in Bangladesh

The inland water fisheries of Bangladesh present several problems derived basically from the way they have been managed as well as from their overall physical and biological environmental conditions. The following is a brief discussion of the main problems identified in the inland waters of Bangladesh:

Too many fisheries agencies and too many management objectives

For long, both inland and marine fisheries in Bangladesh have been exploited as open-access capture fisheries. Over time though, management of fisheries has became the responsibility of several governmental agencies and ministries with principles laid mainly during British rule and subsequently by several Government Acts during the Pakistan period (e.g., Fish Protection and Conservation Act 1950, Tenancy Act 1951 and Estate Manual 1958).

As each participating agency seeks their own objective in formulating their policies, the prevailing management system for fisheries in Bangladesh now presents multi-agency and multi-objective characteristics with several objectives and agencies in conflict (A. Rahman this vol.). This has led to unclear delimitations of responsibilities and management priorities resulting in distorted practices for allocation of fishing rights, collection of revenues control and surveillance of fishing activities.

Exploitation of the fishermen and over-exploitation of the fish resources

For a long time, management of most inland water fisheries has been conducted through a regulatory system consisting of periodic leasing of segments of water areas to middlemen who subsequently organize harvesting activities by engaging sub-lessees, guards, toll collectors and fishermen under various terms and conditions (see A. Rahman this vol.). This system has lead to a mode of production characterized by high dependency of fishermen to lease holders and the appropriation of the largest portion of the total benefits by the various members of the sub-leasing chain at the expenses of the fishermen's share (see Fig. 2). The system has also induced indiscriminate fishing and over-exploitation of the fishery resources in the absence of appropriate incentives for conservation, control mechanisms and surveillance personnel of the government agencies responsible for

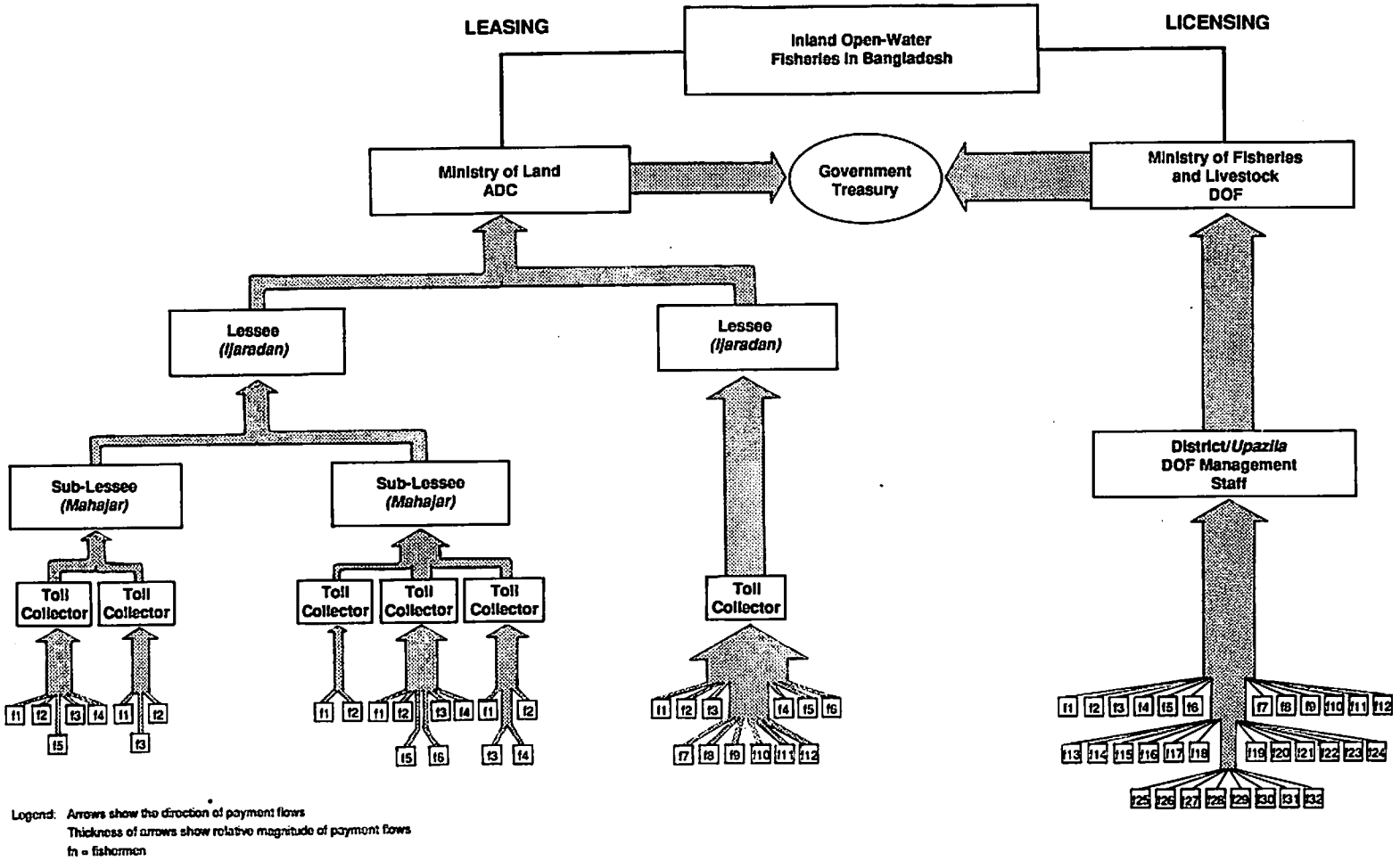

Fig. 2. Chain of intermediaries under leasing and licensing systems in Bangladesh inland water fisheries.

fisheries management.

Also, short-term revenue-oriented water/fish access management policies, designed mainly to raise government funds, have not considered the renewable character of fish resources and have resulted in excessive fishing effort generating a network of social and economic linkages among resource users (fishermen, middlemen, processors, consumers) which is perpetuating and worsening the very inequitable distribution of benefits among them. An increasing inequity in the distribution of benefits among users of the water bodies and fishery resources is therefore, becoming an alarming characteristic of inland water fisheries in Bangladesh.

Pollution, siltation, environmental and public health problems

The pollution of the inland waters of Bangladesh is not only affecting the physical characteristics of the various water bodies but the aquatic life as well and consequently, the human population through consumption of aquatic produce. The three basic sources of pollution of inland waters in Bangladesh are: use of agro-chemicals, domestic waste, and industrial effluents (for details, see Haque this vol.).

Flooded areas recaptured during the off-flooding season for rice and agricultural production are affected by chemical and toxic materials used by farmers to enhance the productivity of land (fertilizers, pesticides, etc). As a consequence, fish habitats have deteriorated as indiscriminate use of these toxic materials has led to their accumulation in the soil, affecting the spawning of freshwater fish in rice fields and to pesticides killing plankton in open-water bodies.

The domestic waste of most human settlements in Bangladesh finds its way into the river streams and water bodies without proper treatment (if any at all).[a] On the other hand, even solid waste which is dumped into empty lots in the outskirts of townships (landfill areas) ends up in the various waters systems during the flooding season. Because of the rapid population growth and the uncontrolled flow of all kinds of domestic effluents, it is difficult to estimate their final environmental impact, especially in the inland water bodies. Although domestic effluents increase the productivity of water bodies and aquatic vegetation proliferates in these areas, the rapid decay of large quantities of this vegetation makes the waters anoxic with eventual localized fish mortality (UNDP 1986).

On the other hand, dumping of untreated toxic or non-toxic materials into the water streams and other water bodies of Bangladesh is commonly practiced with the consequent damage to the quality of fish habitat. For example, textiles and chemical plants in the vicinity of Dhaka discharge their effluents without treatment; the petroleum refinery pollutes the waters of the Karnaphuli rivers preventing its use as drinking water in Chittaghong.

Siltation and sedimentation of the rivers in Bangladesh, resulting from natural process (river flows) and man-made through flood and tidal control constructions, excessive removal of surface water for irrigation, large-scale reclamation of *haors*, *beels* and other depression areas for crop production, is one of the greatest in the world (for details, see Y. Ali this vol.).

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a According to the Population Census (Sample Survey) 1982, BBS, only 2.6% of households in Bangladesh have some kind of human waste collection/disposal system (municipal sewage, sceptic tank, latrine) while 94% is classified as "other arrangement" or "open field bush" (BBS 1989).

Lack of reliable data and information

Although considerable efforts have been made in Bangladesh to establish a data/information system through the Bangladesh Fisheries Resource Survey System (BFRSS) (see L. Ali this vol.), fisheries data and information are still inadequate, inconsistent and unreliable (see Nuruzzaman this vol.). There is a need to reinforce the human, logistical support and financial resources required to collect, process, analyze, store, and disseminate data and information on a regular basis. There is a need to monitor the evolution of important socioeconomic and environmental parameters and to establish a unified system for their data collection, recording and dissemination.

Importance of Appropriate Management of Fishery Resources

The population in Bangladesh is expected to reach over 120 million people by the year 2000, requiring at least one million tonnes of fish just to maintain the current low level of consumption. This implies an increase in fish production of approximately 30 % over the present levels. Inland fisheries are expected to play a major role in the satisfaction of these minimum nutritional requirements of the population of Bangladesh. The task and challenge to resource managers is therefore not only complex and formidable but also unavoidable. Failure to identify and implement sound management strategies and effective tools to solve the existing problems of inland waters, will not only prevent the attainment of the required increase in total supply of fishery products for human consumption on sustained basis, but what is even worse, it will maintain and possibly worsen the existing trend toward over-exploitation and degradation of the environment, the aquatic resources and the economic condition of human population, namely the fishermen. Inland fisheries management will, therefore, need an integral approach, based on firm knowledge of the many factors affecting fish yields. It will require a team-work rather than the usual isolation and compartmentalization of government departments so distinct in Bangladesh; it will require a clear conviction to break existing linkages at the institutional, social and economic level which presently prevents the effective operation of mechanisms devised to control and correct distortions and malpractices in the fishery activities and their management. Finally, it requires the wisdom and patience to evaluate results over a long period to allow important medium and long-term forces to operate (Agüero 1986).

The Government's Experimental New Management Policy

Several international missions and national reports (e.g., FAO 1985; UNDP 1986; UNDP/FAO 1987) have already clearly identified the nature and characteristics of the major problems affecting the inland water fisheries in Bangladesh. In an attempt to solve some of the crucial problems, the government decided in 1986 to adopt a new policy for the management of the inland open-water fisheries throughout the country. The implementation is being made on experimental bases and has become to be known as the New Fisheries Management Policy (NFMP) although its existence is yet to be formalized. The main idea behind the NFMP among others is the gradual abolition of the short-term auctioning or leasing system of the fisheries and the introduction, in substitution, of a system of licensing to genuine fishermen under direct government control and supervision, and thereby freeing the fishermen

from exploitation by the middlemen leaseholders and financiers. Also, through the measures of direct control by the government, the policy aims at ensuring the conservation and propagation of fishery resources in order to achieve a sustained increase in fish production.The NFMP seeks to replace the traditional leasing system by a gear-specific licensing system and thereby, bringing the open-water inland fisheries of Bangladesh under the direct control of the governmental authority.

The main objectives of the NFMP are:

(i) to redirect the major benefits of the fisheries to the genuine fishermen, and

(ii) to maintain and improve the productivity of open-water fisheries on sustainable basis.

The Government's Strategy for Licensing Program of the NFMP

The implementation of the NFMP necessitated, among others, a clear identification of genuine fishermen and fishing communities to be licensed; it was recognized that to be effective, strengthening and reorganization of the local and national administration and the infrastructure was required in order to bring all water bodies under the management of at least one ministerial body so that the new policy could be managed consistently. Considering these, the Government decided to proceed in a phased manner allowing policy makers to "learn by doing" and having the chance to monitor and evaluate the performance of alternative institutional arrangements under different environmental and institutional conditions. Therefore, the first step has been the initiation of an experimental phase associated to an experimental implementation and monitoring project.

Accordingly, the new policy has been introduced in selected areas representing the various water bodies of Bangladesh and the likely management conditions under which future policies may take place. This first phase has been implemented on a pilot scale, with the system to be extended to all public water bodies in five to ten years time. A full framework of the new policy with the necessary legal basis is being prepared and a more comprehensive policy will follow upon the review of the performance of the pilot fisheries.

For the purpose of implementing the first phase, an experimental project was designed by the Department of Fisheries (DOF) personnel with technical assistance from the International Center for Living Aquatic Resources Management (ICLARM) and the financial collaboration of The Ford Foundation. (see A. Rahman, this vol.).

During the last 18 months, several activities have taken place in various aspects of the implementation and monitoring of the NFMP.

The first one was the identification and recruitment of a multidisciplinary team of professionals capable of effectively and independently conducting the task of monitoring and evaluating the performance of the policy as implemented in the various experimental sites. A group of highly trained national specialists with long experience in their respective fields was given this task. As most of the members of the group belonged to the Center for Advanced Studies (BCAS) a contract was signed between the Center and the Government for that purpose with clear and detailed Terms of References. ICLARM has provided continuous technical support to them in methodological as well as practical research and evaluation matters. A system of periodic Quarterly and Annual Written and Verbal Reports to the government was established

Table 2. Training/Workshop activities under experimental project on new and improved management of inland open-water fisheries in Bangladesh.

Activity	Date	Place	No. of participants	Institution/ Individuals	Organized by	Duration
1. Data acquisition training program	15-29 Jan. 1987	Bangladesh	40	DFO/UFO from DOF	ICLARM; DOF	2 weeks
2. Policy training program and field visit in Asia	Oct. 1987	Philippines Thailand Indonesia	8	DOF/MOFL/ BCAS/NGO (CARITAS, PROSHIKA)	ICLARM	3 weeks
3. Microcomputer training for fisheries data processing and analysis	Jan. 1988	Bangladesh	8	DOF/BCAS	ICLARM; DOF	10 days
4. International field visit	Apr. 1988	Thailand	1	MOFL	ICLARM	4 days
5. National workshop on fisheries management	Jan. 1989	Bangladesh	300	NGO/Nat'l. and Int'l Scientists/ FF	ICLARM; DOF;	2 days

Legend:
a) BCAS = Bangladesh Centre for Advanced Studies
b) CARITAS = an NGO that channels funds donated by Catholic church for social and econor progresses in developing countries
c) DFO = District Fishery Officer
d) FF = The Ford Foundation
e) MOFL = Ministry of Fisheries and Livestock
f) NGO = Non-Government Organization
g) PROSHIKA = Proshika Manobik Unnayan Kendra

to allow DOF and the implementing agencies to closely follow the performance of the policy and to receive the corresponding feedback advice on time.

It was recognized from the beginning that the monitoring and evaluation process would require considerable efforts in gathering the necessary data and information and that the local capabilities at the District and *upazila* level would need additional infrastructure support and training. Several training and workshop activities were organized by ICLARM and DOF during the period 1987-1988. A list of activities is provided in Table 2.

Accordingly, ICLARM's Resource Economists designed and conducted a one-month intensive Data Acquisition Training Program for approximately 40 District and *Upazila* Officers which took place in Dhaka. Techniques in questionnaire design, data collection, data processing and the analyses of the basic problems of inland water fisheries in Bangladesh were presented in class-sessions with practical application during field visits.

The need to create a strong awareness among high rank officers of the various concerned inter-ministerial agencies about the problems, implications and benefits of alternative management strategies for inland water resources was also recognized. For that purpose, ICLARM organized and conducted a Policy Training Program in

its Manila headquarters, including field visits in different countries such as Thailand, Indonesia and Philippines. Senior members of DOF (including the present Director of Fisheries), and scientists from BCAS, DOF and NGO participated in this three-week intensive Training Program.

A third, Microcomputer Training Program, was given in Dhaka by ICLARM Resource Economist and the Project Specialist to a selected group of Technical staff of the DOF and BCAS in the application and use of microcomputers to fishery data storage, processing, retrieval, updating and reporting.

Finally, periodic meetings between the DOF Administration Team, the BCAS Monitoring Team and ICLARM's Resource Economist acting as Technical Advisor, have allowed the identification of several areas where problems have appeared and solutions have been suggested. Moreover, an unusual but effective link and communication channel has been established allowing government officers at the highest level to directly interact with researchers, consultants and their own professional staff.

Summary and Recommendations for the Workshop

The complexity of the ecological, economic, physical, biological, social and institutional environment within which inland fisheries in Bangladesh takes place, requires an effort to identify, analyze and rank the various topics deserving priority consideration. Although for analytical purposes it is convenient to clearly identify, separate, quantify and analyze each relevant component, it is important to keep in mind that they are all parts of a single unit of analysis, namely, the inland fisheries of Bangladesh, for which a multidisciplinary, integrated and holistic approach is necessary.

The purpose of this workshop is precisely to gather and share experiences among those implementing and monitoring management policies and those being affected by them so that the main issues and their relevant importance can be properly assessed and alternatives for improvements can be identified.

The following outline summarizes the basic issues and problems most likely to be confronted within the management of inland water fisheries of Bangladesh and therefore provide guidelines for the discussion of the various contributions to the workshop documented in these proceedings.

Theme 1: Environmental Conservation for Sustained Fisheries Production in Inland Waters of Bangladesh

a) Degradation of the physical, biological and socioeconomic environments in inland water fisheries of Bangladesh. Causes, characteristics, trends and impact.

b) Determination of the relevant links and interactions between climate, ecology, living aquatic resources and human interventions.

c) Analysis of the potentials of aquatic resources under alternative management interventions and harvesting strategies.

d) Identification of optimal and alternative sub-optimal levels and characteristics of effort (harvesting) in inland water fisheries and corresponding constraints.

Theme 2: Data and Information Requirements and Acquisition for Inland Fisheries Management

a) Survey and data acquisition problems, alternative solutions and requisites for and components of an effective management data/information system.

b) Data/Information storage, processing, analysis, retrieval and reporting. Methods, techniques, tools, instruments, financial and human requirements.

c) Fisheries Data/Information for management and the National Information System. Boundaries, consistency, aggregation/integration and periodicity.

Theme 3: Alternative Management Options; Leasing and Licensing Access

a) Identification of genuine fishermen and their real potential effort capacity.

b) Political and community acceptance of regulatory policies; monitoring enforcement and surveillance procedures and their infrastructure and financial prerequisites.

c) Identification of mechanisms to make licensing an effective tool for resource conservation and enhancement.

d) Assessment of relative efficiency of alternative access allocation mechanisms under various physical and institutional environments.

Theme 4: Property Structure and Income Distribution in Inland Fisheries

a) Assessment of relative benefits of factor ownership structures; their temporal, spatial and social distribution.

b) Realization, appropriation and dissipation of resource rents.

c) Conflicts among alternative resource uses and multiple users.

d) Availability and access to resources, distribution of benefits and potential contribution of financial resources and institutions to economic development in inland open-water fisheries of Bangladesh.

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The New Management Policy of Open-water Fisheries in Bangladesh Under Experimental Monitoring and Evaluation

A.K. Ataur Rahman
Department of Fisheries
Matshya Bhaban, Park Ave.
Ramna, Dhaka
Bangladesh

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Abstract

This paper starts with a general description of the institutional organization of the government for the management of aquatic resources in Bangladesh. It also describes the present revenue-oriented management system of the government-owned fisheries as conducted by the Ministry of Lands. The problems and drawbacks of the present revenue management system are highlighted. A brief history of the introduction of the New Fisheries Management Policy (NFMP) in selected water bodies of the country is provided. The main features of the NFMP are discussed, which include: (a) gradual replacement of the present practice of leasing of water bodies to intermediaries, (b) introduction of a system of granting fishing rights to genuine fishermen and (c) conservation of fisheries resources. The experimental design to find out a suitable system of management through alternative approaches now being monitored and evaluated in twelve selected water bodies under the new management system is explained and discussed.

Introduction

Bangladesh has one of the richest and largest flood plain systems offering excellent potentials for inland water capture and culture fisheries if properly managed. The *khas*, water areas or government fisheries in Bangladesh, variously known as *jalmahals*, *sariatmohals*, *jalkars*, etc., are the principal sources of fish production in the country. However, during the last two decades, the productive potential of the country's open-water fisheries has declined considerably due primarily to overfishing and implementation of flood control irrigation and drainage projects (see Y. Ali this vol.). During the period 1979-80 an estimated 235,000 t of fish were harvested from the country's huge flood plains. By 1986-87, the production from these flood plains had dropped down to approximately 184,000 t (see Table 1, Aguero this vol.). It is anticipated that by the year 2000, the net negative impact of all flood control projects on the overall inland open-water capture fishery will be a decline in production of 150,000 to 250,000 t, therefore reducing total production of inland waters by approximately 50% (see Y. Ali this vol.). On the other hand, population growth will require an additional total fish supply of more than 250,000 t by the year 2000, just to maintain the current level (22 g/day) of per capita fish consumption which is already low according to national nutritional standards.

The socioeconomic importance of inland open-waters fisheries in Bangladesh and the major problems for their rational management have already been pointed out (see Agüero this vol.). The solution to these problems requires not only a sound management program with coherent measures and policies, but also, a well equipped, trained and consistent institutional structure to effectively carry out the Management Policy.

In this paper, an analysis of the government structure and policies for managing the inland waters of Bangladesh will be presented.

Overview of the Government's Institutional Organization for Fisheries Management

The creation of a Fisheries Department for administration and management purposes in Bangladesh, dates back to the turn of this century during the British rule. It was then redesignated as Directorate of Fisheries (DOF) in 1947, having mixed fortunes in its hierarchical status within the government agencies during the Pakistan period (1947-71) and the post-independence years (FAO 1985). Very recently, when fisheries became a part of the responsibility of the Ministry of Agriculture (MOA), the DOF was relegated to share a Division with livestock in the Ministry. However, since the latest reorganization of the government agencies (1985) the Directorate is now placed separately under the Ministry of Fisheries and Livestock (MOFL). Its main responsibilities include administration, management, development, extension and training. There are two other organizations that work under the administrative umbrella of the MOFL. These are the Bangladesh Fisheries Development Corporation (BFDC) and the Fisheries Research Institute (FRI). However, the principal organization responsible for fisheries development and management is currently the Department of Fisheries (DOF) with marine and inland wings in four administrative divisions with a staff of over 2,500 individuals (see Fig. 1).

In addition, several other government agencies and government bodies like the Ministry of Local Government, Rural Development and Cooperatives; Ministry of Lands; and Ministry of Irrigation, Water Development and Flood Control, with the

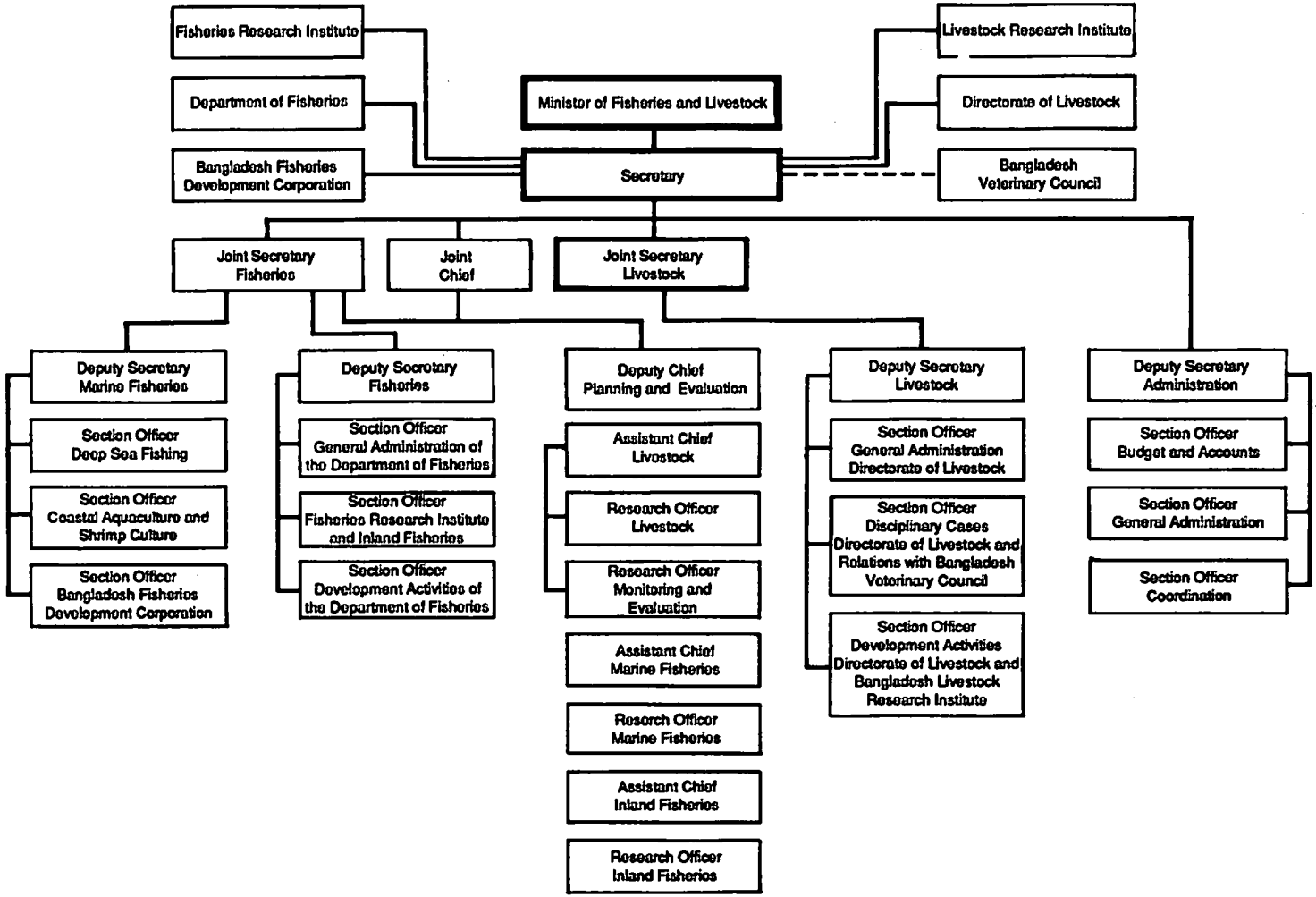

Fig. 1. Organogram of the Ministry of Fisheries and Livestock (MOFL), Bangladesh.

help of their affiliated institutions are actively involved in fisheries administration, management and development. This multiplicity of institutions actively engaged in various aspects of fisheries management and administration has created compartmentalization of responsibilities and authorities with several overlapping functions among them. Table 1 shows various institutions and their corresponding responsibilities in the overall management of fisheries in Bangladesh.

The Revenue-Oriented Management System

The basic mechanism for managing fishery resources in inland open-waters of Bangladesh has been based on the allocation of fishery rights through periodic leasing. Although very recently a licensing system has been introduced for this purpose in selected sites on experimental bases (NFMP), the traditional leasing system, which is more revenue-oriented than the fishermen/ resource-oriented policy is still the dominant management mechanism.

While most *jalmahals* are administered by the Ministry of Lands through their offices of Deputy Commissioners, those within the forest reserves and those subjected to irrigation controls are administered by the Department of Forests and Bangladesh Water Development Board respectively. Fishing rights for water bodies of less than 20 acres in extent are leased by the concerned *Upazila Parishads* (see Naqi this vol.). While the fishing rights are put to open auction, the government gives priority to fishermen's cooperatives with the intention of increasing the participation of more disadvantaged fishermen. Since most of the cooperatives are disorganized with no proper leadership and lack of sufficient financial resources to compete in the bidding process with wealthy intermediaries, successful bidders in public auction often turn out to be white-collared middlemen, who then establish an extensive network of sub-lessees. Fishermen in need of fishing grounds are required to pay these sub-leasing chain members to obtain their access. As generally fishermen do not have a stable and strong flow of financial resources, they must secure fishing rights through other arrangements with the lessee/sub-lessee, such as catch sharing, or as working labourers.

This revenue-oriented management system has the following drawbacks:

(a) With the purpose of obtaining the maximum benefit, the lessees tend to allow the harvesting of as much fish as possible without any consideration whatsoever for conservation, future production and resource sustenance. As a result, overfishing in *jalmahals* over the years has become a common occurrence.

(b) The benefits from the fishery are not distributed on equitable basis and the greater portion of benefits is captured by the lessees or middlemen.

(c) Because of the short-term nature of the lease in most fisheries (one to two years), lease holders have no incentives to undertake conservation measures for rehabilitation of the stock removed annually or for preservation of the water bodies.

(d) Since DOF has no control over the fisheries, meaningful enforcement of the Fish Act is difficult. Enforcement of fishing regulations or other such lease conditions is the responsibility of the leasing agencies (Department of Revenue, Department of Forests, etc.). The agencies show little interest to monitor adherence to lease agreements apart from ensuring that the payments are made on schedule.

Table 1. Government agencies involved with fisheries administration, management and development in Bangladesh.[a]

Ministry	Institution	Activity
Ministry of Fisheries and Livestock (MOFL)	Department of Fisheries (DOF)	Administration, Management, Development, Extension and Training, Production and Marketing
	Bangladesh Fisheries Development Corporation (BFDC)	
	National Institute of Fisheries	Fisheries and Aquaculture Research and Training Research (NIFR)
Local Government, in Rural Development and Cooperatives	Rural Development Board	Fishery components Integrated Rural Development
	Development Programme	
	Registrar of Cooperative Society	Registration & supervision of fishermen coops.
	Bangladesh Jatiya Matshyajibi Samabaya Samity Ltd. (BJMSS)	Development of fishermen coops., operation of ice plants and import of gear
	Bangladesh Samabaya Bank Ltd.	Financing of fishermen's cooperatives
	Upazilas	Management of water bodies less than 20 ha
Land	Land Administration and Land Reform Division	Leasing of publicwater bodies
Irrigation, Water Development and Flood	Bangladesh Water Development Board	Leasing of reservoirs and irrigation canals
Control Industries and Commerce	Department of Commerce	Licensing of fish processing plants
	Bangladesh Sugar Corporation	Processing of shrimp
Shipping	Mercantile Marine Department	Registration of fishing boats
Education	Universities	Higher fishery education
Finance	External Resources Division (ERD)	Administration of external aid
Foreign Affairs		Exclusive Economic Zone negotiations

a) BBS (1980, 1985, 1986).
DOF (1986).

(e) The race for winning the lease of high priced fisheries between the water-lords often lead to litigations.

(f) Because of their preoccupations and their primary responsibility of ensuring law and order, the Deputy Commissioners, as custodians of the *jalmahals* can hardly supervise the day-to-day management of water bodies.

(g) The field officials of the Land Ministry including the Deputy Commissioners do not have the necessary background

to understand the renewable resource characteristics of most fisheries and their vulnerability over time. Equally, the policy of leasing out fisheries to middlemen does not explicitly consider *jalmahals* as renewable resources.

Among the major consequences of this management approach are the increasing over-exploitation of inland open-water fishery resources whose major share of benefits are captured by the intermediaries and the worsening condition of the fishermen.

The New Fisheries Management Policy

The Government of Bangladesh has taken note of all the problems relating to leasing system and consequently has decided in 1986 to introduce the New Fisheries Management Policy (NFMP) (see Agüero, this volume for objectives of NFMP). The main features of the NFMP are:

(a) to establish in a phased manner the right of the fishing community over all the *jalmahals* of the country;

(b) to eliminate the middlemen from the *jalmahals* through the gradual adoption of a system of licensing of water bodies to genuine fishermen or groups of fishermen;

(c) to ensure conservation of resources through biological management.

For proper implementation of the NFMP, a seven-member National Coordination Committee was formed with the Joint Secretary (Fisheries) as its convenor and representatives from Department of Fisheries, Ministry of land, Ministry of Local Government, Rural Development and Cooperatives (MLGRD) and representative from the Bangladesh *Jatiya Matshyajibi Samity*. Similar committees at *Upazila* and District levels were also constituted for proper implementation of the policy and for supervision, monitoring and evaluation of the programme. The main task of the *Upazila* committee is to identify genuine fishermen and organize them in groups as well as to determine fees to be collected against the licence to be issued to the fishermen. Under the above arrangement, implementation of the NFMP started from the Bengali year 1393 (April 1986) in only ten *jalmahals* in different districts of the country. It is unfortunate to note that not long after the new policy got a modest start, interministerial conflicts over right of management resulted in the reformulation or reconstruction of committees at different levels.

Ford Foundation/ICLARM and the Experimental Project

The Ford Foundation has long been active in supporting initiatives designed to improve planning and management of common property resources in Bangladesh. The International Center for Living Aquatic Resources Management (ICLARM) established in Manila in 1977, has been undertaking research and training activities on aquaculture and capture fisheries throughout the world and specially Asia. The Ford Foundation has collaborated with ICLARM to help developing countries in their efforts to manage and conserve their fisheries resources. During the implementation of the NFMP, the Ford Foundation and ICLARM expressed their interest to provide financial and technical support to DOF to help the Government test and develop alternative approaches to managing open-water fisheries. An experimental design was prepared in collaboration with ICLARM in 1986 which has now entered into the second year of its implementation.

Under the project, performance of 12 sites in three environments and four

management options (fishing rules, institutional involvement and intensity of input support) are being evaluated (see Table 2). The three environments represented by the experimental design are segments of flowing rivers, *baors* and *beels*. The segments of flowing rivers include parts of Padma-Jamuna and Meghna river system covering the districts of Dhaka, Faridpur, Comilla and Barisal (see map in Fig. 2). The *baors* are representatives of dead rivers or ox-bow lakes in the southeastern parts of Bangladesh, while the *beels* are parts of natural depression areas in Sylhet and Mymensingh. A licensing system has been introduced in nine *jalmahals* of which six are under DOF management and the remaining three are to be under NGO management.

DOF is applying two different intensities of management in its six licensed fisheries, three under each (see Table 2). Under intensive management, DOF catered for additional management and supervisory manpower, built infrastructures (e.g., landing site) and facilitated credit supplies to the fishermen. These fisheries are Narisa-Padma (flowing river), Kanglar *haor* (*beel*) and Baluhor *baor* (see Table 2). In the other three fisheries DOF is applying normal licensing with the help of its existing personnel (*Upazila* Fishery Officer and his two field assistants). These are Padma-Jamuna Balbant fishery (flowing river), Kanudaha *baor* and Arial Khan *jalmahal* (*beel*). The three fisheries licensed under NGO management are Meghna fishery (flowing river), Simulia *baor* and Roial *beel* (see Table 2). Two non-government organizations (NGOs), the Proshika Manobik Unnayan Kendra (PROSHIKA) and CARITAS are managing these fisheries through group organization of the local fishermen.

All of the above nine fisheries are being monitored through the experimental project under NFMP. By way of comparison, performance is also being monitored in another three water bodies under the existing revenue management system (leasing) administered by the Ministry of Lands. These water bodies are Meghna Naya Bhanguni, Kharincha *baor* and Karcha Nadi in Hijla, Chowgacha and Sunamganj *upazila* respectively (see map in Fig. 2). The main objective of the monitoring exercise will be to provide regular feedback both to the managing agencies and to policy makers on actual performance in each location in terms of productivity, sustainability and distribution of benefits. By the end of the project, sufficient evidence should have been accumulated to establish the desirability of implementing the policy on an expanded scale and the implications in terms of administrative, logistic and other requirements.

In the six DOF-managed sites, a management team composed of DOF personnel will undertake measures to ensure (a) that the waters are fished by licensed fishermen only; (b) that the fishermen obtain necessary bank credit for boats, nets, etc. to replace the loans traditionally provided by the middlemen; (c) that fishing is conducted in accordance with rules designed to encourage conservation and where possible, restocking (*baors*); (d) to ensure that the fishermen receive a fair price for their catch and (e) that fees against licences are judiciously assessed. A multidisciplinary Monitoring Team comprising members of local biologists, fisheries technologists and social scientists was employed for the monitoring purpose. This team has been regularly visiting all the twelve management sites and has been collecting data on the fisheries in close collaboration with DOF management personnel. Activities of the Monitoring Team includes among others the following:

(a) Research design and implementation of monitoring and evaluation activities of the NFMP.

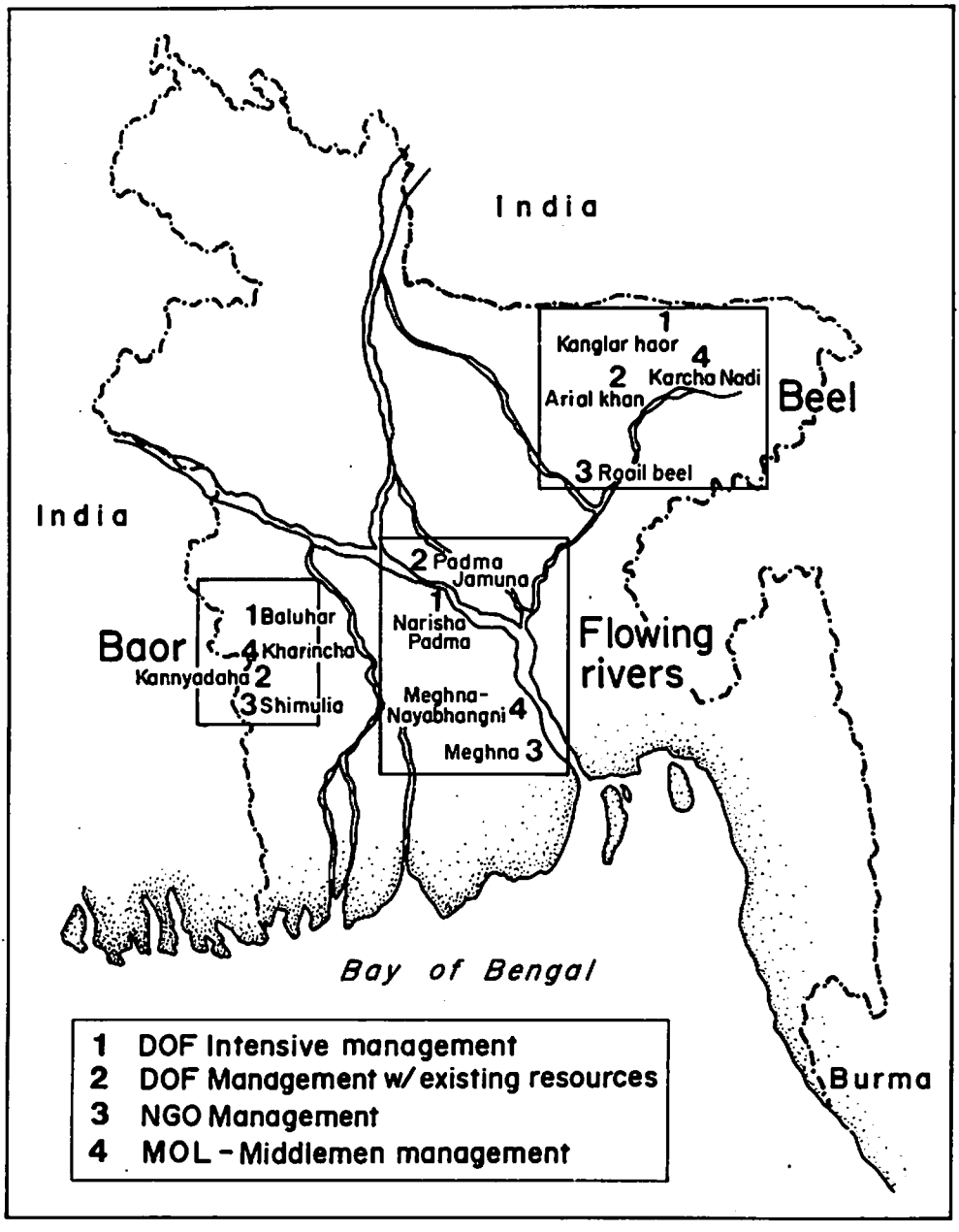

Fig. 2. Experimental project sites under the new fisheries management policy.

Table 2. Experiments in new approaches to the improved management of open-water fisheries in Bangladesh.[a]

Water Bodies Monitored Under the Project				
Environmental Types	Management Types			
	Biologically-based Licensing System (Performance Monitoring)			Revenue Oriented Leasing System (Control)
	(Type 1) DOF-intensive management	(Type 2) DOF-management with manpower	(Type 3) NGO-management existing	(Type 4) LARL/Middlemen management
Flowing Rivers	Narisa-Padma Nadi (Faridpur-Dhaka)	Padma-Jamuna Balbant (Dhaka-Faridpur)	Meghna Fishery (Barisal)	Meghna Naya Bhanguni (Barisal-Comilla)
Dead Rivers (Baor)	Balubor Baor (Jessore)	Kannadaha Baor (Jessore)	Shimulia Baor (Jessore)	Kharincha Baor (Jessore)
Natural Depressions	Kanglar Haor (Sunamgonj)	Arial Khan Jalmahal (Kishorgonj-Mymensingh)	Roial Beel (Netrokona-Mymensingh)	Karcha Nadi (Haor) (Sunamgonj)

Legend:
Type 1 = Intensive licensing management under DOF's supervision and control with provisions of additional manpower, infrastructure and credit support
Type 2 = Licensing management by DOF's existing field staff without any support and facilitie
Type 3 = Licensing management through the NGO resources and group organization of fishermen
Type 4 = Lease management by middlemen

a) DOF (1986).

(b) Collection, processing, analysis and dissemination of data, information and research results of monitoring and evaluation.

(c) Training and assistance for monitoring and implementation of the NFMP.

(d) Policy analysis and evaluation of the NFMP and of alternative options.

ICLARM has provided necessary technical support for research design, data acquisition and processing capabilities (computers, personnel, training) and overall coordination.

Conclusion

Implementation of the New Policy is a new approach to the improved management of open-water fisheries. We cannot say at this stage with certainty that the new management system in its present form is the best. There may be others or even better approaches for management of open-water fisheries. Proper evaluation of the different approaches of management as set forth in the DOF/Ford Foundation/ICLARM project "Experiments in New Approaches to the Improved

Management of Open-water Fisheries in Bangladesh" is of great importance since the outcome of this project is likely to establish administratively replicable means of achieving the sustainability and equity goals set out in the government's NFMP. I hope the participants of this workshop will keep the above spirit in mind and contribute their share in the process of evaluation and monitoring.

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Environment, Conservation and Management of Fishery Resources in Bangladesh

A.K.M. Aminul Haque
Bangladesh Agricultural University,
Mymensingh
Bangladesh

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Abstract

An important requisite for efficient management of fishery resources is the management of the environment, which in turn, contributes to the sustainability of fish populations. Pollution of the aquatic environment of Bangladesh is already causing concern among fisheries people. There is an urgent need to know the nature and effects of all chemicals used in Bangladesh industries, agriculture and public health on the fish stocks. Similarly, there is a need to understand the physiology and nature of responses of fisheries organisms to various stimuli from the environment.

Mere enactment of legislation is not enough; there has to be an effective mechanism to enforce legislation. The estuarine area and the Kaptai Lake call for special treatment so as to reap the maximum benefit out of the vast potentialities. There should be a system for easy flow of information and experience, and easy interaction among government agencies, NGOs including scientists, fish culturists, and fisherfolk. Latest technologies available through satellite imageries may be of help in tackling many of our management problems.

Introduction

Bangladesh is uniquely rich in water bodies. Leaving aside the near-shore Exclusive Economic Zone (EEZ) and the vast seas beyond, to which she has free access, her extensive estuaries and mangroves and her rivers, lakes, ponds, canals, ditches and paddy fields all offer tremendous opportunities for production of fisheries organisms (see Agüero this vol.). With ever-increasing human population, and increasing pressure on land for development purposes other than agriculture, we have, of necessity, to turn to our waters for food as well as for much-needed foreign exchange earnings.

Bangladesh fisheries, however, are not without problems. The most serious of them all is the problem of management - management of the aquatic environment, and management of the fish population.

The present paper aims at drawing attention to some of the management problems in respect of environmental issues and conservation of fishery resources.

Environment

The most important components of the environment for the purpose of fisheries are water, soil, sunlight and temperature.

Water

Naturally occurring water is not just a chemical compound denoted by the formula H_2O; it is more than that. In lotic situations, many minerals and gases are dissolved in water gradually changing its quality. In case of lentic situation also these qualitative changes take place in varying degrees. Quality again, responds to the elements bringing about changes in the seasons of the year. The quality of water determines the quality - and quantity - of phytoplankton, zooplankton and the subsequent life-forms in the food-pyramid. Different forms of fisheries organisms show preference for different qualities of water. In Bangladesh, this accounts for upstream migration of hilsa in certain rivers and not in others, absence of Mahashole in the waters of the plains, for example, and abundance of fish in certain seasons of the year and scarcity in others.

The quality of water, that is, the aquatic environment of the fisheries organisms, gets adversely changed through various human activities, namely use of fertilizers, insecticides and various other agro-chemicals, industrial effluents and burning of fossil fuels.

Problem of pollution

The problem of pollution of aquatic environment concerns no one more than the fisheries people. Pollutants affect fishing industry both quantitatively and qualitatively -- quantitatively by affecting the natural productiveness of fisheries organisms, and qualitatively by affecting the value of such organisms as food (Table 1). The productiveness of the fisheries organisms may be affected in a number of ways:

* the water quality may be changed so that multiplication of planktonic food-organisms may be adversely affected;

* the physiology of the fisheries organisms may be affected interfering, among others, with growth, fecundity, reproduction, and migration; and

* the various stages of life-cycle, from egg to adult, may be affected.

Table 1. Major pollutants in the water and their chain of actions

Source/Type	Chain of Actions
1. SEWAGE	Excessive non-treated organic matter
Flow of rivers and tributaries	↓ Excessive fertilization of water
	↓ Production of poisonous species of plankton
	↓ Toxic concentration in fishery products for human consumption
2. INDUSTRIAL EFFLUENTS	
a. Discharge of heavy metals e.g., Mercury, Cadmium and Copper	Accumulation of mercury components in fish
	↓ Produces mercury toxicity in fish
	↓ Fatal diseases for human consumption
b. Halogenated hydrocarbons	Accumulation in biological foodchain of fish
	↓ Causes contamination in human body from consumption of fish
3. DUMPING RUBBISH	• Nuisance and hazards to aquatic life
	• Dangerous contaminants transferable to human body through consumption of aquatic resources
	• Environmental degradation (pollution of atmosphere and scenery)
4. AERIAL FALLOUT	• Production of radio-active and obnoxous materials
	• Dangerous to aquatic animals as well as to human being consuming aquatic organisms
5. MICROBIAL CONTAMINATION	Ulcerative disease in aquatic animals
	↓ Massive loss of fish
	↓ Degradation of fisheries

On the other hand, the value of fisheries organisms as food may be affected by:

* change in taste, (affecting acceptability)

* accumulation of harmful substances, making their consumption dangerous.

Some pollutants and their action

Sewage. Sewage from cities and towns is usually discharged into rivers to ultimately find its way into the sea. Through transport of organic matters in the sewage in moderate quantities some amount of fertilization of fishing grounds takes place. In many fishing areas, the productiveness of the water is derived exclusively from the discharge received from the land. Thus, for example, the very high productivity of the North Sea, which happens to be one of the most productive fishing grounds in the world, is chiefly the result of continual fertilization with phosphorus and nitrogen from sewage brought in by the Thames, the Rhine, the Elbe and others rivers (Tiews 1972). The very high productivity of the Bay of Bengal is likewise considered here to be enhanced by the discharge of various organic sewage carried in by most of the major rivers of the sub-continent and beyond. The Ganges, the Brahmaputra and the Meghna - three of the mighty rivers flowing through very densely populated areas even before entering Bangladesh, in which country they form an intricate network of rivers, their tributaries and distributories, are already rich in organic matters, which encourage production of fish and other fisheries organisms. Incidentally, it is in Bangladesh where the most extensive mangrove areas of the world are located, which enrich the equally extensive estuarine waters with their organic decomposition (Haque 1979).

However, excessive concentration of organic, putrefiable substances can cause serious damage to fisheries, if the oxygen, present in limited quantities, is used up in the process of putrefaction, thus creating zones which may be sterile for fisheries organisms. Further, excessive fertilization of water bodies encourages production of poisonous species of plankton resulting in toxic concentrations in fisheries products meant for human consumption. Besides, untreated sewage in huge quantities may cause unacceptable concentration of pathogenic organisms locally in waters, which are otherwise very rich in nutrients. Under such conditions, great harm is done to the sluggish bottom-living and sedentary forms, such as loaches, some catfishes and shellfishes.

Industrial effluents. Most of the industrial effluents contain constituents that are harmful to fisheries organisms, and, through them, to human life. These are the heavy metals and halogenated hydrocarbons. In Bangladesh, most industrial effluents are discharged without prior treatment (for details, see Y. Ali this vol.).

(i) Heavy metals - Mercury is possibly the most notable among the heavy metals that concern us. It is almost insoluble in common solvents (0.02 ppm in water). The fact that fishes accumulate mercury compounds, more than other aquatic organisms do, both directly from water and indirectly through their food-chain, and the fact that they constitute a major food item for man, makes humans consuming such fishes vulnerable to mercury toxicity. In the case of Minamata disease that created an emergency situation in Japan some two decades back, the fatal concentration came as methyl mercury content primarily in fish and shellfish (Irukayama 1967). Unfortunately, some aquatic micro-organisms, besides transferring mercury to higher trophic levels, can also transform it into methyl mercury -- the most toxic form of the metal (Jensen and Jernelov 1969).

Mercury is used both in agriculture and in industry in Bangladesh. In agriculture, it is used in fungicides, weedicides, seed protectants, etc. Among the industries using mercury are chlorine and alkali plants (for electrolytic production of chlorine and caustic soda), cellulose industries (for preserving the wet pulp from fungal effect), plastic industries (for catalytic reactions), pharmaceutical industries (for production of diuretics, antiseptics, etc.), paint and varnish industries (for production of anti-corrosive paints), power plants (in special heat engines, instead of water vapour), and industrial and control instrument manufacturing industries (in manufacture of thermometers, barometers, mercury pumps, etc.). The major part of mercury pollution is, however, due to chlorine and cellulose industries.

Some organo-mercurial fungicides at concentrations as low as 0.10 ppb in water are known to reduce photo-synthesis and growth of phytoplankton (Harriss et al. 1970). Fish suffering from acute mercury poisoning show rigidness, widely spread fins, sluggish movements, and "hanging" in the surface with hind part of body turned downwards followed by loss of balance and sinking to the bottom before death occurs (Takeuchi 1966). In people, chronic inorganic mercury poisoning causes nervousness, increased irritability and rhythmical tremor, while organic mercury compounds, particularly methyl mercury, damages the central nervous system, leads to generalized ataxia, constriction of the visual field, and apathy. Since mercury can pass through the placental membrane, teratogenic and foetotoxic effects (Matsumoto et al. 1965) and increased frequency of chromosomal breaks in humans (Skerfving et al. 1970) have been reported.

Other dangerous heavy metals producing toxic effects in man as a result of consuming fisheries products are cadmium (causes softening of bones), copper (causes diarrhoea with vomiting , i.e., *cholera morbus*), and arsenic (causes stiffening of back together with damage to kidneys, i.e., Haff's disease).

These toxic metals even in sub-threshold doses, can cause appreciable disturbance to the physiology of organisms by producing adverse effects on the reproductive physiology, nervous system and behaviour pattern. The particularly dangerous feature of sub-threshold pollutant concentrations in water is that living organisms are able to accumulate so much of these substances through food-chain that they can become dangerous to the health of the next higher trophic level (human consumption), and cause, for example, cancer, damage to the nerves, and also bring about genetic changes.

(ii) Halogenated hydrocarbons -- The use of halogenated hydrocarbons as herbicides and pesticides including DDT, is of special concern to fisheries people. Like the heavy metal salts, they accumulate in the biological food-chain being stored mainly in adipose tissues. When aquatic organisms so contaminated are consumed, they may also accumulate in human body. In case the hydrocarbons are chlorinated, they do not decompose easily -- their decomposition extending over a half-life of several years.

Dumping of rubbish. Rubbish of various kinds is carried with currents or just thrown into our river systems from the banks, vessels, dwelling houses, etc. These are kitchen wastes, remains of cargoes and packaging, engine-room waste, wire, bottles, plastic and other objects. While some of this rubbish decomposes and disperses, others remain suspended, or sink to the bottom. The latter type turns out to be a positive nuisance to the well being of all aquatic life.

Aerial fallout. Aerial fallout of radio-active and other obnoxious materials that get into the atmosphere, is another aspect of pollution of aquatic environment. The fact that Bangladesh is equally susceptible as the rest of the world, and that she receives her waters from rivers flowing through countries beyond her borders (India, Nepal, China), and also that she receives more than her due share of rainfall, and therefore, possibly also of fall-out materials, is a matter of concern.

Microbial contamination. The large-scale microbial contamination of our water bodies resulting in 1987, in heavy mortality of the fish stock due to what has been called "Epizootic ulcerative syndrome" calls for special attention. Investigations are going on to identify the causative agents and to study the epidemiology of the disease. The work done by the Bangladesh Agricultural University (BAU), the Fisheries Research Institute (FRI), and the Department of Fisheries (DOF) of the government of Bangladesh are not yet conclusive. The question now is: should we wait for the results and recommendations of the investigations to first free our waters of the pathogenic microbes, or should we, instead, go ahead with our programmes of fish-farming? The second alternative is obviously the answer. However, we have to try to improve the aquatic environment by appropriate treatment, and go for large-scale production of fish-seed to re-stock our depleted water bodies including the river systems. Table 1 shows a summary of the major water pollutants and their chain of actions.

Soil

The quality of water depends to a large extent on the quality of soil of a basin. In the aquatic environment, soil does not only serve as a basin for holding water, it also acts as a substratum for a multitude of aquatic life directly or indirectly related to fisheries. It interacts with the water it holds, and thereby controls the quality and quantity of aquatic life.

The quality of soil in its turn is determined by size of soil-particles, physical characteristics, chemical composition, type of micro- and macro- flora and fauna (both benthic and pelagic), organic detritus, amount and quality of sunshine received, amount of erosion and amount of siltation, etc. As these may vary with time, it is necessary to assess the over-all quality of soil, and take corrective measures as and when necessary.

While the quality of pond soil may be considered to be relatively "static", that of rivers is "dynamic". Problems, like siltation and erosion in their turn depend a lot on the characteristics of the flowing water - flow discharge, velocity, turbulence, etc. The construction of bridges and culverts, barrages, cross-dams, coastal embankments all have their impact not only on the physical characteristics, but also on the chemical characteristics, as is the case with saline water incursion both in the water and in the soil of the coastal districts due to construction of the Farakka Barrage (Haque 1976). These are multi-faceted problems, and deserve very critical consideration.

Sunlight and temperature

The sun is the source of energy for all earthly organisms and sunlight is one of the most important natural resources for Bangladesh. However, sunlight may get obliterated by clouds or vegetation creating gaseous imbalance detrimental to aquatic life. Further, excessive turbidity of water interferes with the photosynthetic process indirectly affecting aquatic life.

Temperature of water is related to angle of incidence of sunrays and to hours of daylight. Within a certain limit, rise in temperature may be beneficial to fish by increasing their metabolic activities. But in stagnant water bodies about to dry up, rising temperature is usually fatal. This situation can be tackled by having deeper reservoirs dug in such water bodies to hold sufficient water for the fishes during the dry season, or transferring the fishes to some other water bodies with sufficient water for the fishes to survive for the next season.

On the other hand, the heating of waters by heated cooling water from power plants may, in fact, be favourable for aquaculture, as the increased temperature results in increased metabolic activities of the fisheries organisms.

Situation in Bangladesh

Having discussed the major pollutants and other factors affecting aquatic environment, we may now consider the situation in Bangladesh. We propose here to concern ourselves mainly with pollution factors, as the other factors are not as serious.

There is an erroneous, self-deceiving concept that a developing country like Bangladesh need not concern herself with pollution of aquatic environment when she has many other pressing problems to be concerned with. This is a lop-sided view of the situation. In her struggle to achieve industrial development, Bangladesh has been setting up industries at different places in the country. Of these, the paper and pulp industries, the rayon mills, the fertilizer factories, the pharmaceutical industries, the tanneries, and the agro-chemical and pesticide industries are of particular importance in discussing the issue of water pollution. Here, the disquietening fact is that these industries seem unconcerned about the disposal of their effluents. And what is more dangerous, we have hardly any idea of the nature and quantities of such effluents.

Secondly, even without industrialization to any appreciable extent, Bangladesh is already using a lot of agro-chemicals in her effort to boost up agricultural production, without clearly understanding the nature, behaviour and impact of many of the chemicals used. The disturbing reports that occasionally find their way into newspapers about large-scale mortality of fish in certain sections of our rivers, and about huge stocks of agro-chemicals and pesticides remaining unused for years, are of serious concern. This year's unprecedented flood has added another dimension to the problem by flooding of many godowns storing such chemicals.

Need for Monitoring

The fact that we do not know the nature and extent of pollution to which our aquatic environment is being subjected, should not lull us into complacency. We have got to know the nature and behaviour of the chemicals used in our agriculture, public health and industries, the nature and quantities of the effluents, the treatment they receive, and the mode of their disposal, and also to evolve a system of monitoring the nature and extent of pollution. There are, however, difficulties. Collection, processing and storing of samples are themselves quite problematical. The lack of suitable and standard micro-analytical procedures is a serious constraint in monitoring aquatic pollution. These call for regional and international cooperation and coordination.

The use of multi-spectral water colour parameters as indicators of aquatic pollution is full of potentialities for development

of a monitoring system. It is already possible to locate fish and to identify the species from satellite imageries by studying oil films and trace vapours on the sea surface caused by biological activity (Brandt 1971). Our Space and Atmospheric Research and Remote Sensing Organization (SPARRSO) can help us in this regard, if they are told what exactly we want of them.

It is strongly felt that all industries using offensive chemicals and agro-chemicals in the country, should be required by a suitable legislation, to send to the Environment Pollution Control Board of the government of the People's Republic of Bangladesh, all relevant data (including chemical formulae) on the chemicals they use and/or manufacture, the by-products they produce, the effluents they discharge, the treatments, if any, they give to the wastes, and the mode, location and time of disposal of all different wastes.

Besides, there should be a computerized Data Bank attached/accessible to the Environment Pollution Control Board of the government to work as a service department for all manufacturers and users of various chemicals and all research-workers, and to provide up-to-date monitoring information.

In the meantime, a distinct course on the subject of Environment should also be introduced at the Baccalaureate level in universities to create public/scientific community awareness of these issues.

Special Case of Estuaries

Bangladesh is uniquely rich in estuaries - rich in both quantitative and qualitative terms. She has one of the world's most extensive estuaries, and the estuaries are again the richest in quality being continuously fertilized by organic debris mainly from the mangrove vegetation, which again provide a sanctuary for many organisms of fisheries importance. There is practically no limit to what we can do to reap the fullest benefit out of our estuaries.

There are, however, problems. The estuaries in the southern districts crisscross one of the most luxuriant tropical evergreen forests popularly known as the *sundarbans*. These are classified as reserved forests, and all activities there fall within the exclusive domain of the Forest Department. The result is that there is hardly any fisheries management, and the vast potentialities of development of fisheries resources there go unexploited. By some mutually acceptable arrangement with the Forest Department, the Fisheries Department can undertake pen-culture and cage-culture of suitable species of fisheries organisms - finfish, shellfish and seaweeds - in a massive scale.

Another problem in the estuarine area, particularly in the Chokoria *sundarban*, is the large-scale destruction of mangrove vegetation for shrimp culture. This should be done in a planned and scientific way with least disturbance to the environment and the ecosystem.

Conservation

The problem of conservation embraces a multitude of aspects -- the most important being, (i) an awareness of the need for conservation, and (ii) an awakening of the sense of responsibility at all levels, *viz.*, individual, society, and governmental agencies, and these include the whole population irrespective of their involvement or otherwise in fisheries activities.

It needs to be appreciated that efforts at conservation should take into consideration both (a) the organisms of fisheries importance, and (b) the environment.

There are adequate legislations to take care of all aspects of conservation of both the organism and the environment. But these are hardly followed. One fails to understand how a Bangladeshi, whose whole self is said to be made of fish and rice *(machhe-bhate Bangalee)*, can go for indiscriminate catching of brood fishes and juveniles, and exhaust the dwindling streams, *beels*, canals, etc., of fishes leaving nothing for the next season.

One thing that can be done to educate the village folks in appreciating the need of fisheries management, is to select at least one pond in a convenient location in the village for aquaculture purposes and develop it into a sort of aquagarden *(jol-bagicha* or *neerodyan)* with the banks developed as horticulture garden (vegetables and ornamental plants) and bamboo benches at places where villagers and extension workers will be attracted to use this as a sort of community centre (Haque 1978). This is expected to have a salutary effect on the attitude of the rural folk in conservation practices and also motivate them to develop their own ponds and other water bodies.

Policy Issues and Suggestions

There are several ways to increase the fish population or to keep them at present levels. Among these are : (i) conserve what we have; (ii) increase the number through artificial breeding; (iii) reduce mortality, and (iv) improve our knowledge about fish, their environment and their best use.

Conservation

Conservation of stocks

The government should arrange for mass-education of people through different media to make them aware of the need for conservation of both stocks and environment, and also evolve an effective system for enforcement of the provisions of relevant legislation.

For conservation of stocks in the dry season, in all water bodies with drying up problems, deeper reservoirs should be dug so as to work as dry season sanctuaries, and these should be protected by law, and by motivating people.

Conservation of environment

Water bodies. Besides the conventional elements of environment for fisheries organisms, (water, soil and sunlight) there is another aspect of water, that is important to consider. This is its quantity. The most pertinent problems of quantity of water are encountered during (a) dry season, and (b) floods.

Dry season problems. During the drier months of the year, water levels in all water bodies fall, and that affects aquatic life, in some cases endangering their very survival. Conservation of the quantitative aspect of water in water bodies ranging from ponds, roadside ditches, etc., to the big rivers needs a national policy, and in case of rivers, also an international understanding. These are beyond the scope of this paper. Suffice it to say here that different species of fisheries organisms have different requirements in respect of breeding, migration, etc., which require to be understood correctly, and the knowledge transmitted to all concerned - from simple village folks to planners and policy makers - to appreciate the nature of the problem and to find solutions.

Flooding problems. Flooding of water bodies brings about changes of great magnitude and far-reaching consequences to the aquatic environment. Not only that the stocks of fish get dispersed, and

get a chance to escape from the inundated fishponds, thereby causing huge loss and frustration to the pond owners, but also that physical and biological characteristics of the water body get altered, particularly in case of rivers where large-scale siltation of river beds, beside erosion of banks, may take place.

As a lower riparian country, Bangladesh has to reach some understanding with the upper ones, to combat the flooding and other associated problems. It is expected that the efforts already initiated by the government in this regard will be met with success.

It is to be understood that all physiological activities of fishes, such as growth, gonadal maturity, migration, feeding, spawning, etc., are influenced by the environmental factors -- both biotic and abiotic -- the qualitative and quantitative characteristics of water are active determinants. As the nature of response of an organism to a particular stimulus in the environment varies from species to species, it is not possible to suggest a single prescription for all fishes (and other fisheries organisms). Hence, it is imperative to study the physiology and behaviour of all major species of fisheries importance -- and that includes plankton down at the bottom of the food chain.

Artificial breeding to increase fish population

The population of the commercially desirable species of fish including the rare ones such as Mahashole should be increased through artificial breeding, rearing them under controlled conditions to a minimum size for the species before they are released into waters for independent life.

The case of Mahashole deserves special attention. Reservoirs may be dug in the form of pockets in some of the rivers, like the Someshwari, the Kangsha, the Dakatia and the Karnafuli within strategically safe distances from the border so as to hold colder water. The bed of such reservoirs may be covered with boulders and pebbles to simulate the natural environment of this fish, and thus encourage the same to stay on in Bangladesh waters. Further, induced breeding of the fishes should be tried for aquaculture for important species.

Reducing mortality

In order to avoid depletion of stock due to (a) over-exploitation, (b) diseases, (c) pollutants in water, and (d) drying up of water bodies as in the dry season, the following measures are suggested:

It is extremely difficult to limit harvest to any appreciable extent because of the simple fact that a vast majority of the fisherfolk live much below the poverty line with traditionally no landed property and doing only subsistence level fishing. The implementation of a "close day" for fishing every week (*cf.* "meatless day") may however be a feasible strategy. The public information media can play a very important role in motivating all concerned to implement this.

The Kaptai Lake, due to its vastness and depth needs special attention for the management of its fisheries. Small fry and fingerlings of fishes released here find it difficult to adjust. To overcome this problem and to exploit the vast potentialities of the lake the following steps have been suggested (Haque 1978):

* release only fingerlings of a minimum size;
* convert suitable creeks into ponds by constructing cross dams, that may work as road connecting two adjacent hillocks;

* use "floating ponds" in suitable creeks for aquaculture;

* adopt "pen culture" practices in suitable location in the lake

The Chittagong Hill Tracts Development Board is understood to have got very encouraging results by following some of these suggestions.

Research needs for management

In order to increase harvest levels and at the same time maintain sustainable production, we have got to go for intensive culture of fisheries organisms. The development of culture fisheries is contingent on three "f's. -- fry, feed and finance. It needs a good number of fish fry of the proper species at the right time, it needs sufficient feed of proper quality for different age-groups of the fishes, and it needs enough finance for investment.

There is a great need for research to decide on culturable species of fishes for different water bodies and under different culture conditions, and on the most suited exotic species for culture in Bangladesh. Research is needed also for standardization of practices for induced spawning, hybridization and for identification and control of parasites and diseases. Once the supply of fry and fingerlings of the desired species in required quantity is assured, we have to make sure that suitable feed for various stages of different species is available. For this again we need to simultaneously carry on extensive research for development and formulation of the best feed using locally available ingredients for different fishes -- both endemic and exotic -- at their different stages of growth. This is extremely necessary in view of the fact that in the inland fisheries sector, as already indicated, we have got to go for intensive culture of fish, and one of the first pre-requisites for such aquaculture is the availability of supplemental feed of the right type. Along with the development of feed, research has to be carried out on parasites, diseases and deficiency problems.

Since without private sector participation it is not possible to attain food-autarky, it is essential that the rural folk be involved in our aquacultural programmes. Unfortunately, as the vast majority of them lead a subsistence level of life, it is necessary, for their active participation in aquaculture programmes, to ensure availability of the needed finance at the right time.

In matters of policy decision, be it in respect of increasing harvest level and/or reducing fishing effort for sustainable production level, and research on various aspects of these questions, the NGOs including the Fisheries Society of Bangladesh, the Aquarium Society of Bangladesh, the Zoological Society of Bangladesh, Fishermen's Co-operative Societies, as well as industries directly or indirectly concerned with fisheries resources -- fish/frogleg/shrimp processing plants, fertilizer factories, paper and pulp mills, rayon factories -- all have a role to play. On the one hand they may make suitable recommendations, based on their practical experience, to the planners and policy makers, and on the other motivate those directly or indirectly connected with fisheries/aquaculture industries.

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Environment, Conservation and Fishery Resources in Bangladesh

M. Youssouf Ali
ENIMOF Project
Matshya Bhaban, Dhaka
Bangladesh

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Abstract

The inland fishery production system of Bangladesh consisting of the rivers, flood plains, beels, and of estuaries as components of a single integrated system is described.The importance of the flood plains during the monsoon season in the continuation and sustenance of the stocks of a large variety of fish species is highlighted. Interference with this production system through implementation of Flood Control and Drainage (FCD) projects and their impacts is discussed with reference to certain FCD projects. Impacts of submersible embankments on the aquatic production system and species diversity in the haor areas are discussed. Withdrawal of water from large water bodies such as the ox-bow lakes in Jessore area and perennial beels for the purpose of agricultural irrigation and their effect on the fishery production system are indicated. The inland water fishery resources in terms of fish and prawn species and the breeding-migration requirements of some of the important species are presented. Industrial and chemical pollution caused particularly by agricultural pesticides and their possible impacts on fisheries have been addressed. Conservation measures to sustain the populations and stocks of different fish species are noted and their enforcement is discussed.

Introduction

Through Bangladesh, flow three of the largest river systems of the world, namely the Ganges, the Brahmaputra and the Meghna. Their combined flow is nearly 6 million cusecs all of which drain into the Bay of Bengal. They have a total catchment area of about 1,554,000 square kilometers (km^2) of which only about 140,000 km^2 are within Bangladesh, the remaining being in the upper riparian countries (India, Nepal, Bhutan and China). They also bring huge loads of silt. According to different sources, about 2.4 billion tonnes (t) of silt are carried by these rivers every year.

Inland Aquatic Environment in Bangladesh

General description

Bangladesh has altogether 230 rivers, big and small. Of these, 54 are shared with the upper riparian country, India. These rivers have extensive flood plains i.e., low lying land along both shores of the river courses. The flood plains remain submerged for 4-5 months during the monsoon season. The estimated total area of the floodplains in Bangladesh is about 5.5 million hectares. Many of the rivers in the southwestern region of the country had, in the process of changing courses, left behind ox-bow bends which became disconnected from the main rivers thereby turning the bends into isolated reservoirs known as *baors* or oxbow lakes. An artificial large reservoir of economic importance is the Kaptai lake. (see Agüero this vol.) In addition, man-made ponds are also scattered all over the country (DOF 1986).

The waters are fresh in nature in the inland waters except in the southern region where the rivers meet with the sea. Here the conditions are estuarine with a variable range of water salinity. Tidally submersible lands in the south are also used for saltwater shrimp aquaculture.

From the fish habitat point of view, the inland water areas can be divided into two broad categories:

(i) open-water habitats

(ii) closed-water habitats.

Inland open-water habitats are rivers (including estuaries), canals, flood plains and *beels* (deep depressions). They become components of a single integrated fishery production system during the monsoon (wet) season. The open water is either flowing (lotic) or standing (lentic). In the rivers and floodplains of Bangladesh, both lotic and lentic conditions are interconnected.

The pattern of movement and migration of riverine fishes and prawns is controlled by the seasonal flooding in the monsoon season. Fish movement and migration in the rivers are upstream or downstream during greater part of the year and laterally out onto the inundated floodplains during the flood season. The inundated flood plains provide a wide range of habitats congenial for fish reproduction, early developmental growth.

It is from the flood plains that fish productivity in the riverine systems and in the *beels* is enormously enhanced. They also provide habitats for breeding of fish normally resident in stagnant water bodies as well as for feeding grounds for their offspring after birth. The estuarine environment with varying degrees of salinity is another component of the open inland

water fish production system. The environment here offers suitable conditions for the early growth of various fresh water and marine fish and prawns. Closed-water habitats, on the other hand are ponds, coastal brackishwater ponds and oxbow lakes which have minimal or no connections with rivers or flood plains except under controlled conditions. Aquaculture of finfish and prawns can be undertaken in such closed-water habitats under controlled conditions.

Types of Fisheries in Bangladesh

Capture fishery

Fish and prawn populations in the open inland water system are self reproducing and self sustaining. Harvesting such fish and prawn populations is termed as "capture fishery". The catch is composed of an estimated 257 indigenous species of fish and 20 species of prawn, all of which are popular as food. The river component of the open-water system also supports a major carp spawn fishery. Major carp fry (4-5 mm) are collected from various rivers to meet the demands for fish culture in ponds.

Culture fishery

The growing of fish in confined bodies of water like the ponds and oxbow lakes through aquaculture operations is termed as "culture fishery" which is comparable to cultivation of a land based crop like rice or wheat. In both cases, the soil/water has to be properly prepared and seed (rice or fish) has to be planted or sown, nursed, reared and harvested.

Flooding of Inland Waters and its Impact on Fishery Resources

Floods are an annual phenomenon in Bangladesh. About 26,000 km^2 are normally flooded every year (Alam 1988). Accordingly, in years of serious flood, over 52,000 km^2 of land are overflooded. In 1987, 57,270 km^2 were flooded affecting 29 million people directly in 374 *upazilas* and causing loss of 2.10 million tonnes of land-based food crop (Alam, 1988). The flood in the year 1988 was far more extensive and devastations were far greater. According to official sources, three-fourths of the country had been submerged in 1988. Preliminary official estimates had put the number of people directly hit by the flood at thirty million. The flood of 1988 has been termed as unprecedented in the history of Bangladesh. Peak flow in the three major rivers i.e., Ganges, Brahmaputra and Meghna occurred simultaneously. The combined flow of Ganges and Brahmaputra at Goalundo exceeded all previous records. Due to the synchronization of the peak flows followed by lunar eclipse, both depth and duration of the flood were greater. People even in the city of Dhaka had to stay on rooftops for days. These unprecedented sufferings of the people drew world attention and sympathy.

Flooding and impact on fish reproduction

Breeding and reproduction of almost all the inland water fish and prawn species are tightly bound to the sequence of annual flooding. The rise of water level in rivers and streams between February and April triggers physiological changes leading to sexual maturity of fish inhabiting

the flowing rivers. Similarly, early monsoon rainfall in combination with early inundation of flood plains stimulate fish in *beels* and other similar static water bodies to become sexually mature. As soon as connection between the *beels* and flowing rivers are restored by rise of water in the rivers, sexually mature river breeding fishes such as the major carps from *beels* migrate to the rivers through linking canals. In the rivers, the major carps undertake upstream migration, often to a long distance, seeking their spawning grounds.

Tsai and Ali (1985) suggested that the spawning (breeding) grounds of the Jamuna-Brahmaputra stock of the major carps are located in the southern tributaries of the Brahmaputra River on the northeastern slopes of the Letha Range and the Assam Hills in Assam, India. According to them, their upstream spawning migration occurs from late February to late April and the spawning season is in May to June. The resultant stock of new born fry (spawn) move downstream with the water current and enter Bangladesh. On their downstream movement, the fry move laterally or are swept into the inundated flood plains. In the course of the downstream movement, the stocks of fry or spawn are also collected by spawn traders in different rivers and streams.

Some species of inland water fish and prawn make a downstream migration to reach their spawning grounds in the estuaries. One such species is giant freshwater prawn or *golda chingree*. Adults of this prawn make their downstream spawning migration into the estuaries between January and July and breed there. Their fertilized eggs undergo early development in the saline or brackishwater environment. On attaining juvenile stage, they migrate upstream into the freshwater environment in the rivers and onto the inundated floodplains where they feed and grow rapidly.

The hilsa, the most popular fish in the country, resides in the coastal waters of the Bay of Bengal and moves into the freshwater habitat into the rivers for the purpose of breeding or spawning. Their biggest spawning migration coincides with the early monsoon. According to the investigations conducted by the Bay of Bengal Programme (BOBP 1987), hilsa appears to spawn almost year round with the major activity taking place in October and less intense activity in June and March (monsoon, post- monsoon and premonsoon spawning (BOBP 1987)). The peak spawning run starts at the advent of the monsoon and continues until about September to October though fishing activities continue almost throughout the year. The maximum riverine harvest occurs between August and October every year with the lean season being in December to January. Juveniles of hilsa known as *jatka* appear in the lower reaches of the river systems in Patuakhali, Barisal and Comilla districts between November and April apparently for feeding. Massive harvests of *jatka* take place during that time.

Flood-plain fishing

During the flood season, extensive fishing of the fish and prawns feeding and growing in the food-rich inundated flood plains is carried out by the rural population of the country for both home consumption and sale. Fish and prawns resident in their seasonal flood-plain habitat become more vulnerable to fishing in course of their return with the receding waters at the end of the flood season. The production figures of inundated flood lands were about 42% of the total catch from the combined open-water habitats of the rivers, estuaries, *beels* and flood lands during the period 1983-87 (see Table 1, Agüero this vol.).

Degradation of the Water/Soil Environment in Bangladesh and Impact on Fisheries

Degradation due to flood control and embankment projects

Though the annual flooding connecting the different components of the inland water fishery production system is beneficial for the annual expansion of inland open-water fish and prawn populations, it turns out to be a curse for foodgrain production and human settlement. Such loss of food grain and devastation of properties have led to the planning and implementation of projects for Flood Control and Drainage (FCD) development, combined, in many cases, with facilitates for crop irrigation. This process has been changing the aquatic environment of inland water bodies, adversely affecting inland water natural fish production - both in quantity as well as in species diversity (Fig. 1).

Impact of flood control drainage and irrigation projects

Flood Control, Drainage and Irrigation (FCDI) projects have, become a major cause for aquatic habitat obliteration and degradation as far as inland open-water fish production is concerned. Removal or alteration of water surface area in one particular location of the open-water system, besides producing a local loss/reduction of fish production, will adversely affect fish production in other components of the system.

In the Master Plan Organization (MPO) an exercise was undertaken to assess the irreversible loss of fish production that had already taken place by June, 1985 and that is likely to occur by the year 2005 A.D. As shown in Table 1, it was estimated that a total of 814,414 hectares of flood plains have been removed from the open-water fishery production system until 1985 and another 2.0 million hectares of currently flooded lands would be rendered flood free by the year 2005 A.D. Thus, by the year 2000 an estimated 110,000 t of loss of harvest may occur (Table 1).

Chandpur Flood Control, Drainage and Irrigation Project. Under the project, an area of 555 square kilometers was poldered with high embankment all around to prevent flooding of the area. The project is also provided with facilities for improved drainage through regulators, and sluice gates. A

Table 1. Estimates of irreversible harvest loss that occurred by July 1985 and likely to occur by 2005 A.D. due to loss of inundated flood plains.[a]

Area of floodland (flood plains) removed	Minimum loss of fish harvest from the floodland @ 37 kg/ha/year (t)	Maximum loss of fish harvest @ 55kg/ha/year from the floodland (direct harvest) and from rivers and beels (contributed by the flood lands) combined (t)
(i) 814,414 ha (up to June 1985)	30,133	44,793
(ii) 2,000,000 ha (by year 2005 A.D.)	74,000	110,000

a) MPO (1987).

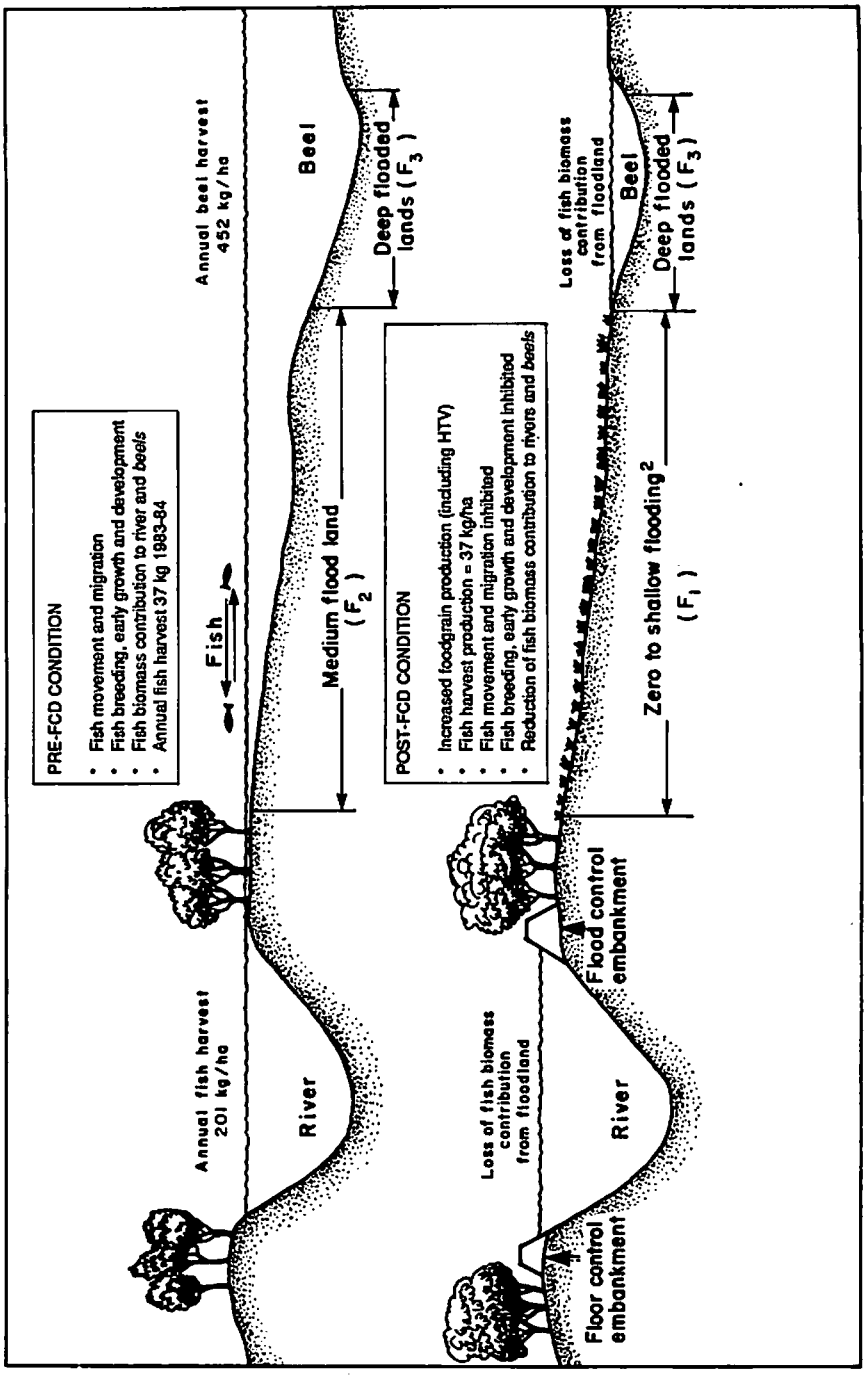

Fig. 1. A schematic representation of the impact of flood land removal on fisheries through Flood Control Drainage Projects in Bangladesh. Fish harvest (BFRSS) refers to 1983-84. F_1 refers to a land type with a flood depth of 0.03 m; F_2 to a flood depth of 0.3 to 1.80 m; F_3 to a flood depth of >1.80 m.

major river system, i.e., the south Dakatia River and associated water bodies within the project area were cut off by the project structures from the remainder of the open-water system. Impacts of the project on fisheries were studied in the seventies and early eighties by the Department of Fisheries (DOF) and M/S Snell Environmental Group, USA under the Project - Irrigation Fisheries Development Programme (IFDP). Construction of the embankment and blockage of the south Dakatia River were found to produce the following impacts (MPO 1987).

(i) Overall fish production within the project area declined by 35 per cent within two years following operation of the project.

(ii) The regulators on the river prevented recruitment of major carps into the south Dakatia River. This resulted in the disappearance of a highly valued capture fishery of major carps in the part of the river inside the project area.

(iii) A high valued commercial fishery of giant freshwater prawn in the south Dakatia River inside the project area were replaced by low valued prawn fishery of smaller sized species of prawn (i.e., *Macrobrachium lamarrei* and *Caridina* spp).

(iv) Eighteen species of fish of tidal or estuarine origin (e.g., hilsa, *pangas*) used to be available in the south Dakatia River capture fishery. With the closure of the river in the post-project phase, all these species are prevented from entering the river by the project regulators and embankment structures.

Muhury Irrigation Project. This is also an FCDI project encompassing an area of 690 km^2 falling in the old districts of Noakhali and Chittagong. The engineering structures are the embankments and a cross-dam and regulator at the mouth of lower Feni River estuary. The cross-dam, completed in February, 1985, has altered the physical, chemical and biological characters of the aquatic environment of the Feni River system. Upstream of the dam, the water now remains fresh round the year, the seasonal movement of the "salt wedge" being restricted. The nursery grounds of those species which require a brackishwater regime for development of their juveniles during the dry season have been destroyed. The characters of the Feni River estuary in the downstream of the dam have also undergone drastic change with increase in water salinity. The dam prevents the upstream migration of hilsa from the estuary and thus has eliminated the commercial hilsa fishery in the Feni River above the cross-dam.

Blockage of upstream migration of hilsa by barrages has also been reported in the River Ganges in India. Jhingran (1983) reported that after completion of the Farakka Barrage in 1973, the hilsa landings in the River Ganges upstream of the barrage were reduced by more than 99%.

The overall impacts on fishery production system of FCD and FCDI are briefly summarized below:

(i) Flood control measures restrict the flood plain and modify the amplitude and timing of flooding.These two, working together, reduce fish productivity and species diversity.

(ii) Flood control inhibits access of fish to breeding and feeding areas, thereby reducing or eliminating fish reproduction. Early growth and development of fish conditioned to feed in floodlands are retarded.

(iii) Reduction in habitat, particularly in the flood plains, caused by flood control and early drainage is expected to reduce the production of fish biomass in proportion to the habitat removed.

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(iii) Reduction in habitat, particularly in the flood plains, caused by flood control and early drainage is expected to reduce the production of fish biomass in proportion to the habitat removed.

(iv) Inhibition of fish movement and migration for reproduction and growth.

The MPO for Water Resources Planning, Bangladesh, presented two broadly conceived schemes for utilization of the main river resources. One is a pair of barrages on the River Brahmaputra to supply water by gravity flow to the Northeast and Northwest regions and the other barrage on the River Ganges to divert water into the Southwest region. From the Ganges barrage water would be pumped from the river to distributaries. These barrages, as and when constructed, would eliminate spawning migrations of anadromous (i.e., migrating from sea to rivers) fish like hilsa and catadromous (migrating from rivers to sea) migration of fish and prawn such as *golda chingree*. This would bring an end to hilsa spawning in the rivers leading to decline of hilsa populations in Bangladesh in the Bay of Bengal. Migration of hilsa juveniles into the rivers between November and April would also be adversely affected because it is during these months that diversion of water for crop irrigation at the barrages would be highest.

Catadromous migration of *golda chingree* and other such species would also be prevented during January to July. Similarly, the return migration of the juveniles and early adults of *golda chingree* to freshwater habitats between June and August would be affected detrimentally by the barrages.

Impacts of submersible embankments

The low lying area in the Northeastern region of Bangladesh (in Sylhet and Mymensingh districts) is known as *haor* region. Every monsoon, this region is deeply flooded (i.e., goes under flood water to depths of 1.8 meter and above). Within the *haors* there are also *beels* or deep depressions. During the monsoon floods the entire area of *haors* including the *beels* and rivers remain under a single body of deep water providing an expanded habitat for fish. With the recession of flood water, the *beels* become isolated bodies of standing water with fish stocks concentrated in them for dry season shelter.

These *beels* remain connected with rivers through small *khals* or channels. These channels usually become dry during the peak of the dry season. During the period from late February to April, when water levels in the rivers slowly rise, these channels receive water and the connections between the *beels* and the rivers become restored. Brood stocks, especially of major carps, then migrate from the *beels* to the rivers for further upstream migration to their breeding grounds. Where these channels have been closed by the submersible embankments, fish migration from *beels* within embanked *haors* towards the rivers is prevented. Portion of channels outside embankments may receive rising water from the rivers, but the portions inside the embankments remain dry until June when flood water overtops the embankments. Thus, broods of carps residing in such *beels* within the submersible embankments would be prevented from breeding. The closure of channels linking the *beels* with the rivers may not only inhibit reproduction of the carps resident in the *beels* but also would reduce their overall abundance in other *beels* and associated river systems both within and outside of the region. This is possibly what had happened in the Karchar *beel* within a *haor* surrounded by submersible embankment where the harvest in 1984 had only 0.15% of *rui*, 1.15% of *kalbaush* and 2.64% of *ghonia* but no *katla*, *mrigal* and *nandil*. In contrast, in the Bhogli *beel* and Sukchan *beel*, which were not surrounded by embankments, the harvests had over 30% and 50% respectively of *kalbaush* and over 10%

and 28% respectively of *ghonia* (Table 2). In Karchar *beel*, the proportion of miscellaneous small fish was 61% whereas the same was 7% in Bhogli and 10% in Sukchan *beel*.

This process indicates that even though *beels* within *haor* areas may continue to exist, the fishery in them will be reduced and will become dominated by low valued species after the *beels* become surrounded by submersible embankments.

Dominance of low valued species in the catch from Kanglar *haor*, another *beel* in the *haor* basin located near Karchar *beel* has been observed. Kanglar *haor* has also been surrounded by submersible embankment. Both the Kanglar *haor* fishery and Karchar *beel* fishery are included as sites in the Project - "Experiment in New Approaches to the Improved Management of Open-water Fisheries" (ENIMOF) of the Directorate of Fisheries.

According to the Third Interim Report of the Master Plan Organization (MPO 1984), the primary irrigation season for the Northeast Region is January to March whereas for the Northwest, Southeast, Southwest and Southcentral Region, this period is from February to April. During the period, both surface and groundwater resources are abstracted. This has affected open-water capture fishery production by further reducing the already low dry season water surface area that provide dry season fish habitat. Abstraction of surface water is done from not only the rivers and *beels* but also from *baors* or oxbow lakes and large man-made reservoirs. Water withdrawals from standing water bodies during the dry season often lead to conflicts between rice growers and fishery lease

Table 2. Catch composition of fish in Bhogli, Sukchan and Karchar beels in the Sylhet-Mymensingh Haor Basin, 1983-84. [a]

Species	Local Name	Bhogli Wt. (kg)	beel %	Sukchan Wt. (kg)	beel %	Karcher Wt. (kg)	beel %
Labeo rohita	*Rui*	897	4.05	1,398	3.76	44	0.15
L. calbasu	*Kalbasu*	6,704	30.32	18,378	50.02	324	1.15
L. gonius	*Ghonia*	2,290	10.36	10,614	28.73	746	2.64
Catla catla	*Katal*	49	0.22	705	1.91	-	-
Cirrhinus mrigala	*Mrigel*	12	0.25	485	1.32	-	-
Wallago attu	*Boal*	4,840	21.89	552	1.49	3,127	11.08
Mystus aor	*Air*	5,168	23.38	761	2.06	1,359	4.82
Channa marulius	*Gazar*	4	0.05	199	0.54	86	0.31
Notopterus chitala	*Chital*	384	1.73	182	0.49	57	0.20
Silonia silondia	*Silond*	5	-	-	-	-	-
Puntius spp.	*Puti*	-	-	-	-	1,508	5.34
Gonialosa manminna	*Chapila*	-	-	-	-	1,802	6.38
Ompok pabda	*Pabda*	-	-	-	-	1,952	6.92
Miscellaneous	Mixed small	1,752	7.06	3,577	9.68	17,207	60.99
Beel area (dry season)		92.30 ha		21.05 ha		79.70 ha	
Harvest per hectare		239.30 kg		1,750.00 kg		353.75 kg	
Percentage of major carps in the catch		45.20		85.40		4.00	

a) DOF (1983, 1984).

holders/fishermen. Increasing withdrawals of ground water for irrigation usually accelerate seepage loss of pond water thereby decreasing the pond water level to below the requirement for fish culture.

Impacts of coastal embankments

In the southern districts of Bangladesh, the low lying lands on both sides of tidal rivers and *khals* are inundated by brackish water during high tides. During the period of inundation, such inundated areas act as temporary nursery and feeding grounds for the larvae, juveniles and fry of many estuarine and marine fish and shrimp. From the 1960s, embankments have been constructed to provide protection of land from brackishwater/saline water inundation. This has permanently removed the nursery and feeding grounds for the marine and estuarine fish and shrimp. To precisely quantify impacts of this loss on marine and estuarine stocks of fish and shrimps, long term surveys and monitoring would be necessary.

Construction of coastal embankments also brought an end to the traditional brackishwater shrimp and fish culture in dry months alternated with a crop of rice cultivation in the wet season in the Khulna region, particularly in the Satkhira district. Brackishwater shrimp and fish farming now being carried out by cutting the Water Development Board embankment, has given rise to conflicts of various natures in Satkhira and Khulna.

Degradation of water/soil due to natural causes

The single important natural cause is siltation of river beds and lowlying lands in the floodplains by 2.4 billion t of silt that are carried by the rivers every year. According to estimates (Sideliner 1988), rivers have gathered about 7 m of silt in the last 17 years and navigability in the waterways has become reduced to 1,770 kilometers (km) from 5,149 km in the winter months. Considering the depth requirement for navigation at 1 m, in the winter months, most rivers in the southwest region suffer acute water shortage. Such shallowness and summer drying up of rivers obviously impact fishery production adversely.

According to Mr. E.F. Durrant, Senior Water Resources Engineer, of M/S North West Hydraulic Consultants Ltd. of Canada, working in Bangladesh (personal communication 1985), in the future, sluices and regulators of Flood Control Projects in the north eastern region will be designed and operated in a manner which would force the water from the bottom of the flood water column into the flood plains so that silts get dispersed over the lowlying lands and *beels*. This concept, when implemented, will hasten the disappearance of *beels* thereby irreversibly eliminating these fish production sources.

In the Padma-Jamuna-Balbant fishery, a flowing river, under management of DOF with existing resources under ENIMOF, it was reported that *pangas* stocks during last winter months did not accumulate in the deep pool within the portion of the fishery in Harirampur *upazila* as the concerned pool was rendered shallow by the flow of sand & silt dredged up in the upper reaches of the river near Aricha to maintain navigability of the river.

Degradation induced by industrial wastes, agro-chemicals and organic pollution

Ahmad and Reazuddin (1986) have reviewed the situation of industrial pollution on water systems in Bangladesh. According to the authors, in setting up industries, no consideration was given to their impacts

on the environment. The authors summarized their views as follows:

"The developments have been made without taking environmental considerations into account i.e., without giving due considerations to patterns that are less destructive to the environment, without making the design of technologies that will have less destructive effects upon the environment, without giving due thought for siting and for rational use of the natural resources and without giving thought for the life styles of the neighboring people. Therefore, the level of pollution from our industries are very much significant and in some cases alarming which has created severe localized environment problem".

The industrial establishments are mostly located on the shores of rivers and other waterways. These industries discharge their liquid and solid wastes into the rivers without any regard to the damages that the effluent discharges can cause to the aquatic environment and living resources within that environment.

Ahmad and Reazuddin (1986) cite the situation that prevailed in the Karnafuly Paper Mills Ltd. (KPM) sited on the shore of Karnafuly River in Chittagong region. In this mill, there was no external treatment plant for effluents. Facilities to recover "black liquor" generated by cooking bamboo, wood chips and bleaching system are most inadequate. Besides dumping solid wastes, fibre, bark, wood particles, solids and inorganic compounds into the river, the mill discharges 1,050m^3/hour of bamboo and wood extraction products, spent cooking liquor, used chemicals for bleaching, etc. into the River Karnafuli, polluting the aquatic environment several miles downstream and upstream of the river. This pollution has caused decline

Table 3. Typical analysis of river water and pollution load in the Karnafuli river at different locations, April, 1984 - March, 1985.[a]

Location	pH	EC (micro-mhos/cm)	Chloride (mg/l)	Total Alkalinity (mg/l)	S.S. (mg/l)	D.O. (mg/l)	BOD (mg/l)	COD (mg/l)
Middle of	7.7	245	18	55	240	6.5	38.0	65
Karnafuli river	6.8	134	6.2	34	59	5.0	4.2	49
near Bambooghat	6.0	100	2	16	19	4.0	0.4	30
Side of	8.5	750	100	460	101	509.0	22.0	68
Karnafuli river	7.3	218	16	37	43	4.4	3.8	45
near Dovashi-Bazar	7.0	120	3	18	11	0.1	1.0	30
Middle of	7.6	250	28	60	46	5.6	3.2	55
Karnafuli river	7.2	150	7	36	31	5.0	2.0	42
near Dovashi-Bazar	6.7	120	3	18	12	3.8	0.7	26
Side of	8.4	-	-	-	58	7.4	2.9	104
Karnafuli river	7.9	-	-	-	49	7.0	2.2	79
near Patenga	7.6	-	-	-	23	6.5	1.6	40
Acceptable value of the parameters in the case of use of the river for fish	6.5 to 8.5	-	-	-	50 or less	at least 7	5 or less	

a) ESCAP (1988).

in fish production in the river. Fish kill caused by the effluents from a fertilizer factory on the shore of Sitalakhya River (near Dhaka) in March to April was a regular phenomenon in recent years. This is believed to be caused by the ammonia discharged and leaked from the Urea Fertilizer Factory. Department of Environmental Pollution Control (DEPC) scientists have recorded a level of 200ppm of ammonia in the Sitalakhya River water at the sites of fish mortality (Bhouyain 1983).

In Fenchuganj under Sunamganj district, two industrial units, one pulp mill and one fertilizer factory are located on the shore of Surma River. Fish caught in this river downstream of Fenchuganj are reported to emit foul odor. A run of hilsa in the Surma River at this site is also reported to have ceased. Both are believed to be the effects of effluents discharged by the industries at Fenchuganj.

Industrial pollution by nearly 144 industries located near or on the shore of Karnafuli River and the adjacent Bay in Chittagong has been described in ESCAP (1988). According to this report, all the industries discharge their untreated toxic waste directly into the River Karnafuli or the Bay and none of these industries have any existing or planned pollution treatment facility. The polluting industries in the Chittagong area, according to ESCAP (1988), are: 19 tanneries, 26 textile mills, 1 oil refinery, 1 TSP plant, 1 DDT plant, 2 chemical complexes, 5 fish processing plants, 1 asphalt bitumen plant, 1 steel mill, 1 paper mill and rayon complex, 1 soft drink factory, 2 cement factories, 2 soap and detergent factory, 2 pesticide manufacturing plants, 4 paint and dye manufacturing units and 75 other light industry plants. An analysis of Karnafuli River water and pollution load was made for a one year period from April, 1984 to March, 1985. Some results of this analysis are reproduced in Table 3.

Khulna is another area which has a number of industries that drain and dump their wastes and effluents into Bhairab and Passur Rivers. None have monitoring or treatment of pollutants activities nor has the DEPC carried out any survey in this region to assess the extent of pollution (ESCAP 1988).

Besides Chittagong and Khulna, industrial units are also located in other parts of the country e.g., Ghorasal and Polash along the Sitalakhya River, Fenchuganj and in greater Sylhet along the Surma River, and sugar mills in various places like Gopalpur (Rajshahi), Mobarakganj (Jhenidah) and Setabganj (Dinajpur). Reports of fish kill from sugar mill effluents are not uncommon.

Another source of inland water chemical pollution in Bangladesh are the chemical insecticides and pesticides. Chemical insecticides and pesticides affect fish life in various ways causing direct death of fish in different stages of their life. In sub-lethal doses, these chemicals alter fish physiology, specially the reproductive physiology. The chemicals also kill micro-organisms, plankton and invertebrates altering the food chains in the aquatic habitats. In Bangladesh, use of insecticides and pesticides is on the rise. Commonly used chemicals are aldrin, malathion, toxaphene, diothiocarbamate, dinitrocompounds, copper compounds, 2,4-D, various rodenticides, dieldrin, benzene hexachloride, etc. DDT is also used for mosquito control. These chemicals enter the rivers, *beels*, etc., as run-off and pollute the aquatic environment. Pesticides and other persistent organics used in Bangladesh in agriculture and the probable pollution load in sea water in 1984-85 have been summarized in ESCAP (1988) (Table 4).

Table 4. Estimated amount of pesticides and other persistent organics used in agriculture in Bangladesh and probable pollution load in sea water.[a]

Persistent organics, by types	Sales of pesticides in the country -July, 1984 to June, 1985 (t)	Amount received by coastal water through river run off (t/year)	Estimated pollution in Bay of Bengal (t/year)
Organo-mercurial fungicides	40.61	10.45	10.15
Halogenated hydrocarbons	891.81[b]	222.95	222.95
Polychlorinated biphenyls	0.00	0.00	0.00
Organo-phosphorus	1991.26[b]	498.06	498.06
Agro toxic agrochemicals	74.33[b]	18.58	18.58
DDT	1038.00[c]	250.00	250.00

a) ESCAP (1988).
b) Monthly Statistical Bulletin of Bangladesh (1985).
c) Pesticide Association of Bangladesh and Plant Protection Department (1986).

According to Majumdar (1988) the current year's flood (1988) caused an unprecedented chemical pollution of river water.

This was caused by submersion of stores and godowns holding toxic chemicals by various industries and toxic chemicals being washed away. The author also states that each of the three distillery units in the country used over 265,000 liters (l) of toxic chemicals per day. Effluents from one such distillery was enough to pollute an entire region. The biochemical oxygen demand of the chemicals released by these was as high as 60,000 mg/l against allowable limit of 50 mg/l. These distilleries also discharge untreated effluents into the inland water system which consume dissolved oxygen in water making the environment unfit for fish, plants and other living organisms. Pollution by domestic wastes and sewerage is also caused in Bangladesh.

So far, no serious effort has been made to develop and implement measures to protect fish and other aquatic living organisms from the ravages of pollutants in the inland water system.

State of fishing pressure and implication for sustained fish production

Fishing i.e., harvesting of fish in the open inland waters of Bangladesh is unregulated. Fish harvesting is done not only by professional fulltime fishermen but also by almost all members of rural households as part-time fishermen round the year. During the monsoon floods when fish populations disperse all over the habitat range, they become available practically at the doorsteps of the people. This easy accessibility combined with the popularity of all the inland water fish and prawn species in all their life stages make them very vulnerable to capture.

In the dry season, fishing becomes confined to more permanent water bodies. These fisheries are leased out by the Revenue administration and the lease holders allow access to any number of fishermen who want to enter the fishery on payment of fees or rents (see A. Rahman this vol.). In the *beels* also, year round fishing is done by residents of adjoining villages for smaller sized fish usually free of charge. Fishing for large sized fishes is normally organized by the lease holders. Many annual *beels* are drained to catch the last living specimen of fish.

No systematic attempts have so far been made to study and assess fishing intensity and fishing pressures on the continuation and sustenance of the populations of all the species of fish and prawn. A study leading to open-water carp fisheries management was carried out under the Fisheries Resources Survey System Project of the Directorate of Fisheries, Bangladesh in 1985 (Tsai and Ali 1985).

The study identified three stocks of major carp in Bangladesh. These are (a) Padma River stock, (b) Brahmaputra River stock and (c) the Upper Meghna River stock. All the three stocks, according to the study, have declined. The Brahmaputra stock has declined due to (1) embankments, (2) sedimentation and (3) in some degree, overfishing. The Padma stock has been seriously depleted to a level that threatens the fishery. The factors contributing to the Padma stock depletion are (1) Farakka dam, (2) embankments, (3) sedimentation and (4) overfishing. The Upper Meghna stock has been depleted mainly by overfishing. Tsai and Ali (1985) also incorporated some recommendations for management of major carp fishstocks in the open inland waters.

The other important fishery is the hilsa fishery. A short-term investigation programme was undertaken by BOBP in 1985-86. The investigations covered all environments of hilsa - riverine, estuarine and marine. Although there was no clear evidence that the hilsa fishery is over-exploited, the report recommended not to encourage increase in fishing pressure until comprehensive studies to monitor the fishery can be organized (BOBP 1987).

The next economically important fishery is that contributed by large fresh water prawns, particularly the giant freshwater prawn or *golda chingree*. Due to increased demand and high price in the international and local markets, populations of *golda chingree* have become exposed to intense fishing pressure in recent years.

The situation in respect of the fishery of other various fish and prawns is not expected to be different.

Increase or decrease in the fishing pressure on different stocks of fish and prawns can be decided only after appropriate and comprehensive studies are carried out.

By all indications, the need to reduce fishing effort for stocks of majority of the fish and prawn species has become evident. The need for reducing fishing efforts for major carp stock has been clearly identified by Tsai and Ali (1985).

The instruments through which reduction in fishing efforts can be ensured is the formulation and proper enforcement of fish conservation rules and regulations. Bangladesh has a Fish Conservation and Protection Act since 1950 called Fish Act 1950 (East Bengal Act XVIII). Many rules have been promulgated under the Act since 1950 but unfortunately these have never been seriously enforced. Causes of the failure to enforce the rules under Fish Act 1950 in the past need to be carefully evaluated before attempts are made to establish other fishery regulations in Bangladesh (Tsai and Ali 1985).

Conclusions and Recommendations

In the light of the situation described in the preceding paragraphs, it will be evident that to sustain the inland water fish populations it is necessary to:

(a) reduce or minimize degradation and destruction of inland water aquatic environment, and

(b) progressively convert the present unregulated capture fisheries in the open waters to regulated fisheries.

A number of measures have been proposed and recommended in the Final and Technical Reports of the MPO to minimize or eliminate adverse impacts on inland water fish production caused by FCD and FCDI projects.

Various suggestions and recommendations also have been made (Tsai and Ali 1985) for management and conservation of major carps. BOBP's report on Hilsa Investigations in Bangladesh (BOBP 1987) similarly contains suggestions and recommendations for hilsa fishery management. The Twenty Year Fishery Development Plan for Bangladesh (FAO/UNDP 1985) also contains various suggestions.

These recommendations and suggestions deserve to be seriously examined for adoption and implementation.

Simultaneously, studies on the population dynamics of fish and prawn stocks of all important species under fishing should be started seriously and in right earnest. In initiating a population dynamics study programme, the first and foremost necessity is competent manpower (i.e., fisheries biologists) fully conversant with the principles of fisheries management. They should also have practical experience in field techniques for carrying out such activities in the field. Presently, such manpower, as far as known, is inadequate. This deficiency was acutely felt in the Hilsa Investigation Programme of BOBP (1987). It is suggested that steps are taken immediately to create and make available such manpower within the fisheries agencies of the country.

Finally, it is emphasized that fish and other aquatic living resources in the open waters of the country are common-property renewable natural resources as elsewhere in the world. Management of these resources should also be done in Bangladesh based on principles and methods practiced elsewhere in the world for managing and using such common-property renewable natural resources.

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Panel Discussion

Dr. M.A.H. Pramanik
Chairman
Space Research and Remote Sensing Organization (SPARRSO)

The two papers on the theme "Environment, Conservation and Fishery Resources in Bangladesh" are particularly important in the present day context when fish mortality, habitat loss and fish disease have become the talk of the day. The first paper by Prof. A.K.M. Aminul Haque has provided an excellent review of the environmental aspects of fisheries, the conservation of fish habitat and the fisheries resources. The author has rightfully stressed the need to know about the nature and behaviour of the environmental pollutants and the need to monitor the pollution. One important method suggested by Prof. Haque in this regard is through remote sensing techniques, which is in line with SPARRSO's thinking in recent times.

In dealing with the conservation problem the author stressed (i) a common awareness of the need for conservation and (ii) an awakening of the sense of responsibility at all levels. Prof. Haque briefly described various problems encountered in conservation and suggested some important remedial measures.

In the second paper, Dr. M. Youssouf Ali provided important data on the conservation of the environment. These relate to industrial wastes, agro-chemicals and organic pollutants. The author cited a number of useful references on these types of works, which are informative and give a real status of the situation.

The paper identified problems in relation to fish production due to human intervention in natural flow of waters through Flood Control Drainage (FCD) and Flood Control Drainage and Irrigation (FCDI) projects, construction of barrages, submersible embankments, etc. He has clearly demonstrated, with data, that the net effect of these types of human intervention on fishery resources is the reduction in fish habitat. As mentioned by the author, a recent investigation by the Centre on Integrated Rural Development for Asia and the Pacific (CIRDAP) also supported this claim.

But it seems that there is a real dilemma: FCD/FCDI projects have valuable contribution to Bangladesh agricultural crop economy, while they produce adverse effects on the fishing economy. It is difficult to say what should be the level of compromise. Nevertheless, the recommendations made by the authors are worth considering.

Dr. Kazi Zaker Hossain
Professor, Department of Zoology
Dhaka University

Prof. Haque gave particular emphasis on the pollution of the aquatic environment and referred to causes such as discharge of sewage, industrial effluents, dumping of rubbish, aerial fallout and microbial contamination, presenting only theoretical review of these causes. One surely would expect results of some actual studies undertaken in the country to qualify these causes. Prof. Haque, however, admits the lack of such studies by saying that "we have hardly any idea of the nature and quantity of such effluents". Prof. Haque very rightly regrets "the lack of suitable and standard micro-analytical procedures" as a "serious constraint in monitoring aquatic pollution." One wonders, why we still lack such a procedure. Is it because of the lack of financial resources and personnel or of initiative?

Prof. Haque identifies four causes for depletion of fish stock: (i) over-exploitation, (ii) diseases, (iii) pollutants in water, and (iv) drying up of water bodies. He, perhaps does not consider environmental degradation (siltation and habitat loss) as a cause of depletion. The audience expected some tangible suggestions from him as remedies. But the suggestion of "fishless day a week" like "meatless day" is not at all feasible.

On the other hand, it is unfortunate that in spite of a galaxy of fisheries biologists in the country, no one still knows what causes the so-called "epizootic ulcerative syndrome" in fish. Finally, Prof. Haque rightfully remarks, "there is hardly any logic in exporting food fish depriving the country's population, for earning some foreign exchange, and then utilizing the foreign exchange in importing vitamins for undernourished population".

Dr. M. Youssouf Ali's paper dealt mostly with the degradation of aquatic environment and its impact on fish population. In addition to the consideration of general theoretical aspects, he has cited examples from the studies undertaken within the country from time to time. It is clear from his paper that the country's fish and fisheries production has been going downhill. Considering the effects of FCD/FCDI projects as amplified by Dr. Ali, one is inclined to ask some obvious questions: a) have the FCD/FCDI planners even pointed out to the government the adverse consequences of such measures on the environment? b) have the fisheries scientists/experts, responsible for fisheries development during the last few decades, ever drawn the attention of the government to the devastating consequences of these measures on the country's open-water fish production?

One knows from the outside that government gave second highest priority to fisheries. National and international agencies have put a lot of effort to strengthen the fisheries sectors with manpower and other paraphernalia. But why is it that having such a huge concern on fisheries affairs, we now hear from horses' mouth that our fish production is rapidly going downhill.

Survey and Data Collection in Rural Fishing Communities for Fisheries Resources Management

A. K. M. Nuruzzaman
Bangladesh Agricultural Research Council
Farm Gate, Dhaka
Bangladesh

Nuruzzaman, A.K.M. 1989. Survey and data collection in rural fishing communities for fisheries resources management, p. 55-60. *In* M. Agüero, S. Huq, A.K.A. Rahman and M. Ahmed (eds.) Inland fisheries management in Bangladesh. Department of Fisheries, Dhaka, Bangladesh; Bangladesh Centre for Advanced Studies, Dhaka, Bangladesh; and International Center for Living Aquatic Resources Management, Manila, Philippines. 149 p.

Abstract

This paper deals with the problems and issues of survey and data collection in rural fishing communities in Bangladesh. The problems of fisheries data collection are mainly institutional, financial and technical. Major institutional problems hindering data collection efforts in fisheries are the lack of coordination among agencies dealing with fisheries. The budget and manpower shortage of the Department of Fisheries (DOF) has also affected its data collection effort. Present irregularity, inconsistency and lack of representativeness in the data have to be removed through provision of trained manpower to DOF, coordination with other departments/agencies and use of improved statistical systems.

Introduction

There has been a great deal of interest in assessing the potential fisheries resources which can be rationally exploited either from marine or inland waters of Bangladesh. This interest has stemmed from two reasons: (i) the near depletion of traditional fishing grounds, which have been over-exploited particularly in inland open waters i.e. rivers, *haors*, *baors*, *beels* and other reservoirs, through the long established indiscriminate fishing practices, and (ii) the interest of the country to increase harvest of protein foods from both fresh and marine waters.

The implementation of a comprehensive management policy through governmental intervention in the administration and management of the inland open-water fisheries is considered essential in order the protect the productive potentials as well as to distribute the benefits from fisheries in favour of genuine fishermen.

This paper deals with the problems and issues of survey and data collection in rural fishing communities for fisheries management in Bangladesh, especially in the context of inland fisheries.

Information and Data Needs for Fisheries Management in Bangladesh

Recently, the fisheries sector has been receiving much attention from all quarters. Detailed plans have been drawn by the government for research, development and management in the distinct areas of marine, brackishwater and inland (open-water and closed-water) fisheries. A number of measures have already been taken by the Ministry of Fisheries and Livestock (MOFL) and the Department of Fisheries (DOF) to streamline the development and management efforts. Despite these, there is a significant lag in the availability of crucial data and information to guide policy design and its implementation. For instance, empirical data on the fluctuations of *hilsa* population and on the impacts of Flood Control and Drainage (FCD) or Flood Control, Drainage and Irrigation (FCDI) projects on fisheries are rare and inadequate (Y. Ali this vol.). Without such data it is difficult to draw any management plan with regard to the *hilsa* fishery and fisheries that are affected by non-fisheries projects like FCD and FCDI. Thus, before we go for making further planning we need basic data. This is indispensable for sound management of fishery resources for the benefit of community, nation and society as a whole.

The inland open waters of Bangladesh are characterized by highly productive ecosystems which support a broad range of fisheries activities. Rational management of these resources should be based on a sound database system. Exploitation of such resources must be based on their sustainable utilization in order to meet present and future development opportunities. A long term management perspective which is comprehensive and environmentally sustainable is needed. The necessary prerequisites for this are collection, analysis, documentation and dissemination of information on present trends in resource development and its impact on various socioeconomic groups, especially the fishermen and the consumer.

Furthermore, in the context of Bangladesh, fisheries management needs to consider a wide range of social and economic benefits including their distribution among various social groups from resources use. Therefore, socioeconomic data are as important as the data on environmental, biological and technological aspects of fisheries.

Problems of Fisheries Data Collection in Bangladesh

For a long time collection of fisheries data was not considered important. However, the Bangladesh Fisheries Resources Survey System (BFRSS) at DOF has in recent times (1983) established a framework for collection and dissemination of fisheries data and information in the country (BFRSS/DOF 1984). Surveys of fishermen and fishing communities are considered as the main source of data and information by the BFRSS (see L. Ali this vol.). However, the data and information collected by DOF through BFRSS are still inadequate to serve the growing need of management planning in line with the government's thrust of implementing a rational management policy. The main problems of fisheries data collection are as follows:

Institutional problems

Lack of information cell

There is no distinct data bank or information documentation unit, and there is no regular publication of documents regarding resources, extent of exploitation, records on damages by floods and booklets of "technology-packages". There is no built-in mechanism in the fisheries departments for disseminating information to the fishermen and community i.e., no active extension services are available in the country.

Lack of coordination

Besides DOF as an affiliated institution of MOFL, the fisheries activities in Bangladesh are also carried out by various government agencies, NGOs and private entrepreneurs (see A. Rahman this vol.). Some agencies/departments have their own way of collecting data. These give rise to various confusing statistical figures. There is a lack of coordination between the effort of DOF and other agencies in ensuring consistency and uniformity in the collected information.

Inter-agency conflict

The problem of data and information is exacerbated by unclear and ill-defined intra-governmental responsibilities. Management responsibilities invariably overlap since most governmental departments and special agencies are organized by functions, lateral linkages among them are absent. These linkages are imperative to have correct information on the fisheries sector for management, policy planning and research.

Financial problems

Budget and manpower shortage

The manpower and budget available to DOF in Bangladesh for covering all aspects of fisheries data collection are very limited. Because of these limitations, economics of scale are impossible and often, one or only a few officers are employed to cover all of the many functions coming under the heading of fishery offices, e.g., administration, management and advice on resources, etc. As a result, resource assessment, collection of fishery information and on other socioeconomic data are hampered.

Collection of basic data on fisheries is often perceived to be unimportant, particularly since the collection of data is seen mainly useful for long term planning. In the absence of staff and facilities to properly record, store and analyze the data, collecting statistics may be seen to be less important than the day to day priorities with which the officials have to deal.

Technical problems

Lack of uniformity of data collection system

The gathering of information is greatly affected by non-uniformity of the system. It has been observed that indigenous methods are followed in the measurement of inputs and outputs in fishing in Bangladesh. Data collectors often get confused and fail to record the exact data on the catch and other aspects due to these discrepancies in units of measurements, thus data collected becomes highly unreliable and inconsistent.

Lack of support services

There are no distinct support services for survey and data collection, especially for the remotest rural areas. It has been observed that the data collectors do not even approach the fishermen or farmers. They sometimes manipulate data according to their choice, perceptions or preferences and put them on record.

Guidelines for Data Collection

In order for the data to be able to provide a meaningful set of information, the following features and characteristics should be ensured in the data collection system:

Regularity in the collection of data

Parameters that change seasonally should be observed regularly. For example, there is a considerable fluctuation in the abundance and availability of fish in the open waters during various seasons of the year. Therefore, data should be collected at sufficiently regular intervals (e.g., months) to assess seasonal variability in the fisheries.

Homogeneity in the approach and unit of measurements

Homogeneity in approach and unit of measurement will make data or information collected over different time and space easily comparable.

Consistency

In the context of inland fisheries where a variety of species of fish are harvested and a wide variety of gear and techniques are used, consistency of data on various parameters is essential, especially on technical parameters, such as the catch per unit of effort.

Representativeness of the sample in the case of sample survey.

It is alleged that the sampling frame as well as the size of sample considered in the BFRSS data collection is inadequate, thereby distorting the representativeness of the information. Therefore, a more accurate sampling frame should be constructed and a larger sample size should be used.

Suggestions and Recommendations

Distinct budget for data collection

Administration, management, relevant research and information gathering functions should be carried out simultaneously at DOF to make the development projects successful. For gathering and disseminating information, separate budgets are required. There appear to be no firm guidelines as to the prior allocation of the level of expenditures that should be devoted to data collection. In designing and operating a statistical system in a severely limited trained manpower situation, it must be recognized that the results may not be

accurate. To be cost effective, it is important to identify the types of data needed, and the priorities and procedures for the collection, and the budget and manpower available for implementation of the system of work for gathering information.

Objectives of the survey

The main objectives should be spelled out. Our existing opportunities for various fisheries expansion, i.e. kinds and quantities of land, water and infrastructure, if possible by using remote sensing technology should be assessed (see Haque this vol.).

Coordination with other departments

In planning a fisheries information service, MOFL will have to ensure that all the fisherworkers of the country coordinate with other organizations while collecting relevant data, in order to make optimal use of existing resources and manpower in the country. Collection methods based on an interview approach and sampling surveys are continuous processes; these have to be done with care and by skilled personnel.

Economic performance of fisheries

Information would be needed on the economic performance assisted or otherwise affected by various actions of the government and private sector. There is no knowledge on the ratio of return to input of private and government investment in fisheries sector. For these purposes, information is needed on fish prices at various levels of transaction for various categories of fish and how these respond to changes in supply, and on price received at landing points and on costs of catching, processing, and distribution of locally caught fish. In many cases it will prove advantageous to consider different approaches to collection of information for artisanal versus industrial fisheries.

Improvement of BFRSS data

The effort of BFRSS in providing us with fisheries data is very recent and therefore, it needs much improvement. To ensure good quality of data on continuous basis, the following aspects require special attention:

a) Recruitment and training of fisheries statistical officers and fisheries economists to minimize errors in the data as well as periodic checking of the survey system by sampling experts.

b) Survey of collection of shrimp larvae for culture must be implemented (prospective sites, size of catch, mode of catching, socioeconomics). The density of stocking and the total areas under shrimp culture must be estimated so that shrimp resources in the country can be managed rationally.

c) The stock sizes of pelagic and demersal fishes including shrimp in the marine environment should be estimated. This data collection should be organized on a continuous process (marine environments).

d) Processing should be computerized and distinct units of a data bank should be established at DOF and at the Fisheries Research Institute (FRI).

e) Regarding aquaculture data, the present research strategies look very inadequate. A comprehensive sampling programme covering various major species and space for aquaculture is essential. Several sub-stations for research sampling in representative locations should be established.

Use of computers

Researchers are exposed everywhere to computer facilities. Through the facilities of computers extensive data sets can be typically handled for storage, review, analysis and final presentation of output in a

systematic way. In processing and analyzing fisheries data, more use of computers should be ensured.

Improvement of the present statistical system

A great deal of discrepancy in the available data on fisheries is still prevailing not only in Bangladesh but other countries of the region. The aquaculture production statistics are still merged with catch statistics and it is often difficult to segregate them. The total production of fish in Bangladesh has been differently illustrated by various reports, mainly prepared by experts. Sometimes the difference is too large to be ignored. This requires improvement.

Conclusion

Data and information in fisheries have long been fragmented without any authentic sources. Recently, we are becoming aware about our aquatic resources through BFRSS. Even though it is meagre, it is a positive sign. We have still got to go a long way to provide more basic information for making pragmatic fisheries development programmes in the future. Emphasis should now be placed on the types of data that are essential for future plans and programmes. Alternative methods of data collection should be tried; for example, logbooks or sales slips may be legislated as a pre-requisite for licensing fishermen and dealers.

Data gathering efforts should also be aimed at ensuring a high level of reliability of the data. Quality control methods should be introduced to ensure reliability of the data produced and estimates generated from collected data.

The questionnaires and source documents used in collecting various types of fishery-related data should be modified in the light of special requirements and local conditions. It should be borne in mind that although useful information can be accumulated by non-systematic data collection, or "census approach", a proper and representative sampling scheme is essential.

The following types of activities invite our attention for revision and modifications:

* Fish production data through a frame survey of traditional and artisanal fisheries
* Aerial frame survey which is still to be done by the Bangladesh Space Research and Remote Sensing Organization (SPARRSO)
* Inventory of industrial fisheries characteristics
* Socioeconomic survey and statistical survey
* Costs and earnings survey of fishing crafts and gears both for mechanized and non-mechanized boats
* Household survey and fish consumption rate
* Demographic characteristics of pond owners.

Finally the importance of systematic and accurate recording and timely reporting of all data collected during a survey, as expected, must be stressed.

A well conducted survey becomes useless if the data are inaccurately recorded, if they cannot subsequently be identified to the position at which they were collected, or if they are subsequently lost due to a poor recording system.

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Survey and Data Collection in Rural Fishing Communities for Fisheries Resources Management in Bangladesh

Md. Liaquat Ali
Department of Fisheries
Khulna Division, Khulna
Bangladesh

Ali, M.L. 1989. Survey and data collection in rural fishing communities for fisheries resources management in Bangladesh, p. 61-70. *In* M. Agüero, S. Huq, A.K.A. Rahman and M. Ahmed (eds.) Inland fisheries management in Bangladesh. Department of Fisheries, Dhaka, Bangladesh; Bangladesh Centre for Advanced Studies, Dhaka, Bangladesh; and International Center for Living Aquatic Resources Management, Manila, Philippines. 149 p.

Abstract

This paper describes the existing survey and data collection system in the fisheries sector of Bangladesh.A frame survey followed by regular catch assessment survey were established by the Department of Fisheries (DOF) through the FAO/UNDP supported Bangladesh Fisheries Resources Survey System Project initiated in 1979. This has been a regular effort of DOF. In addition, more detailed environmental, tecnological, biological and socioeconomic data are also being collected in 12 selected sites through the project "Experiments in New Approaches to the Improved Management of Open-water Fisheries in Bangladesh" since 1986. The paper suggests recomendations for the improvement and strengthening of the fisheries statistical system in Bangladesh.

Introduction

Bangladesh is blessed with vast inland waters and abundant fisheries resources. Unfortunately, due to lack of proper management and due to man-made and natural causes, the fish production from inland open-water resources has declined greatly resulting in increased poverty among the fishing communities (see Y. Ali this vol.). The revenue-oriented management policy based on leasing out fishing access rights in open-water bodies which has prevailed for long in Bangladesh, and the behavior of most middlemen induced by this leasing system have not only led to increased fishermen's poverty but also caused the fish population to decline (see A. Rahman this vol. for drawbacks of revenue-oriented management system). In Bangladesh, all open-water bodies are owned by the Ministry of Lands, which manages their access for fishing by leasing out through auction for collection of revenue. Under the existing system, rivers are divided into arbitrary segments, each segment being known as a "fishery" or *jalmahal*. Similarly *beels*, *baors* or ponds owned by the government fall under this category. There are about 10,000 *jalmahals* in Bangladesh. The lessees of these water bodies are much more concerned with maximizing their private revenues than conserving the resources at sustainable levels and therefore allow harvesting of as much fish as they can without considering the future of the resources. This situation has been a main cause of the decline of fish production in open waters.

Realizing this situation, the government has recently (1986) adopted the New Fisheries Management Policy (NFMP) for the management of inland open-water of Bangladesh. The objectives of the NFMP are mainly to improve the economic condition of the genuine fishermen and to ensure a sustainability in the open-water fisheries production (see Aguero, A. Rahman this volume). Thus, a total of 150 *jalmahals* were brought under the new management policy (10 *jalmahals* in 1986-87 and 140 *jalmahals* in 1987-88).

A total of 150 *jalmahals* were brought under the new management policy during 1986 (10 *jalmahals*) and 1987 (140 *jalmahals*).

In order to assess the impact of the new management policy and to test and develop alternative approaches to managing open-water fisheries for establishing administratively replicable means of achieving sustainability and equity, an experimental project namely, "Experiments in New Approaches to the Improved Management of Open-water Fisheries in Bangladesh", has been taken up by the Department of Fisheries (DOF) with financial assistance of The Ford Foundation. A local research group, the Bangladesh Centre for Advanced Studies (BCAS) has been engaged to undertake the study with the technical assistance of a small group of scientists from the International Center for Living Aquatic Resources Management (ICLARM) in research design, data analysis and evaluation of open-water fisheries management options.

This paper describes the type of data needed for fisheries development, monitoring, planning and management. The methodology for survey and data collection used and information/data available including problems and facilities for data collection under the DOF existing survey system and under the experimental project are discussed.

Need for Survey and Data Collection

The effective implementation of open-water fisheries management requires a thorough knowledge of the fish stock

and its dynamics to allow the regulation of fishing effort and/or fish catch for harvesting the stock at desirable levels.

The size of any fish population and its dynamics under exploitation is determined by four primary factors namely, (1) recruitment of new individuals, (2) growth, (3)natural mortality and (4) mortality due to fishing. Human action determines fishing mortality while other factors may also be affected by human action since they are interdependent.

In order to estimate the primary parameters mentioned earlier, data of the length and weight of fish, species-wise catch by type of gear, fishing effort, age, size at maturity, etc. are needed. An efficient data collection system along with skilled manpower and facilities for data collection and processing is necessary for this purpose (see Nuruzzaman this vol.).

On the other hand, increase of fish production through fisheries management is interrelated with the improvement of the socioeconomic conditions of the fishing community. In order to take any measure for improvement of the socioeconomic conditions of fisherfolks, a full understanding of their problems and the reason thereof are needed. This requires identification of the socioeconomic parameters and gathering reliable information/data about the socioeconomic condition of the fishing community. The following information/data are considered to be essential for the purpose.

a) Family structure and earnings

b) Property structure, occupation and income costs, and returns and profits of fishing units

c) Occupation and source of income

d) Education and health of fisherfolks

e) Family income and expenditures structure

f) Living conditions of fishing communities

g) Social status and security

Existing Survey and Data Collection System in the Fishing Sector

In order to develop, manage, and monitor the fishery sources including the provision of information for planning and the formulation of fisheries development programmes and taking up improvement measures of the socioeconomic conditions of the fishing folk, the following two surveys and data collection programme are at present being carried out in Bangladesh.

Fisheries resources survey system project (UNDP/DOF)

The activities under the project include:

(a) Inventory survey of different types of water bodies and their area including, fishermen, fishing crafts and gears used.

(b) Estimation of fish catch by species, gear and season (month) and types of water bodies. The fisheries of Bangladesh according to their nature have been classified into the following 10 sectors and separate sampling techniques have been developed to estimate the total catch from each category:

1) Riverine fishery (river, canal, estuary)

2) *Beel* and *Haor* fishery (depressions)

3) Flood land fishery (seasonally flooded area, paddy fields, etc.)

4) *Kaptai* Lake fishery

5) *Baor* fishery (Ox-bow Lake)

6) Pond fishery

7) Shrimp Farm fishery

8) Artisanal Marine fishery

9) Industrial Marine fishery

10) Sundarban (Forest) Area fishery

Methodology of data collection

Riverine fishery. All fishing villages along the river were identified and all fishing units were enumerated by type of gear through a frame survey. Rivers were classified as primary, secondary and small rivers in each district (old district). In each district, three villages from the primary river and another three villages from other rivers were selected for catch assessment survey. In each selected village, 1 to 5 fishing units of each type of gear have been selected according to the number of fishing units for observing daily catch of each unit. Catches of the selected units are observed twice a month to estimate average daily catch per unit.

Pond fishery. Numbers and area of culture, culturable and derelict ponds have been estimated through frame survey. In each old district, five ponds of each type have been sampled for observing and recording monthly catch and hence the annual catch (i.e., production) per unit area of pond. Total pond production, is estimated from unit area production.

Beel fishery. Total *beel* area by district has been estimated. Two typical *beels* in each *Upazila* have been selected and catches in those *beels* are observed to estimate unit area catch for each district and then total catch for each district is calculated from the unit area catch.

Baor fishery. Some *baor* are managed by DOF and their catch is recorded regularly. For privately managed *baors*, catch is estimated by stratified random sampling techniques. Stratification has been done for two different size groups (area of 100 acres and above and below 100 acres).

Flood land fishery. In seasonal flood waters, mainly subsistence fishing is undertaken by the villagers. An estimate of subsistence fishing households in different localities of the country has been made. Two typical subsistence fishing villages are selected to observe catch from a sample of fishing units and from this observation daily and monthly catch per fishing unit is estimated.

Kaptai Lake fishery. The lake is managed by the Bangladesh Fisheries Development Corporation (BFDC). The catch from the lake is landed in BFDC's landing center at Rangamati and Kaptai and is recorded by BFDC personnel.

Shrimp farm fishery. Total shrimp farm area by upazila has been estimated through a complete survey. Catches of 12 farms in Chittagong-Cox's Bazar zone and 20 farms in Khulna zone are used to estimate per unit area catch from which total catch is calculated.

Sundarban fishery. All activities including fishing in the Sundarban forest area are managed and controlled by the Forest Department. The Forest Department records fishing effort and catch.

Artisanal marine fishery. Marine artisanal catch is estimated from unit catch and total fishing effort data already available through survey.

Marine industrial fishery. As per a marine fisheries rule, fishing trawlers record their catch and provide this to the fishery department.

Manpower and other facilities

Only 46 field investigators (Fishery Survey Officers) are available under the statistical system of the DOF for collection of data from 10 sectors of fisheries as stated above. They are posted in different district headquarters to cover a defined zone. They are not sufficient for the survey

work needed. At least one investigator with one assistant in each of the 64 districts is required. Besides, they do not have sufficient transport facilities for their movement for collection of data from different sectors of fisheries. Sufficient funds for travelling and operation and maintenance of vehicles (motorcycles) provided to them and stationaries are also not available.

The system has two units of microcomputers which are insufficient for storing, processing and analysis of all data. Most of the data processing is done manually. There is no provision of personnel for computers. Some officers are working with the computer in addition to their normal duties. Computer capacity with trained manpower is needed for this statistical system.

Experiments in new approaches to the improved management of open-water fisheries project

An experiment is being conducted for monitoring the fisheries and socioeconomics of the fishing community under the NFMP. The objective of this monitoring process is to assess the impact of the new management policy on the sustainability and on the improvement of socioeconomic conditions of the fishermen. It is hoped that it will also provide guidelines and better information to recommend alternatives for managing the open-water fisheries and improving socioeconomic conditions of the fishermen. Twelve fisheries of three different environmental conditions under four different management systems are held under the experimental management (see Agüero, A. Rahman this vol.).

Data collected from the above mentioned twelve fisheries for monitoring are as follows:

(a) Environmental, technological and biological data:

* Description of water bodies *(jalmahal)*
* Water quality and productivity
* Description of different types of fishing effort (craft, gear and manpower) and estimation of their number
* Catch by gear
* Length and weight data of important species

(b) Socioeconomic data:

* Family structure
* Property structure (assets)
* Occupation and sources of income
* Income and expenditure
* Sociocultural profile
* Living standard

Methodology

First, attempts were made to determine the sampling frame data for each of the 12 sites (shown in Table 2, A. Rahman this vol.). Sampling frames for six sites were available from DOF. Therefore, sampling frame data for the remaining six sites were collected. A sampling design along with a questionnaire for collection of data on fisheries and socioeconomic of the fishing community was prepared. A stratified random sampling technique was adopted for administering the questionnaire. A list of fishermen with all types of gear in use was made for the 12 sites. This formed the sampling universe for each of the fishery sites. Based on this information on each site, fishermen were stratified according to fishing gears used.

Since the sampling frames in the river sites were large, a sample covering 2% of the universe was chosen at random from each strata. However, in the *haor*

sites, the sampling frame was relatively small and therefore, a 10% sample was taken from each strata at random. When the sample size involved a fraction, it was rounded off to the next highest number.

Following the above procedure, 143 samples were selected from the 12 sites to administer the questionnaires for both technobiology and socioeconomics of the fishing community.

Results of Survey and Investigation

Fisheries resources survey system

Data collected under the Bangladesh Fisheries Resources Survey System (BFRSS) has now become a regular effort and compiled information are being published as Annual Fish Catch Statistics of Bangladesh by the DOF. The statistics contain sector-wise total annual catch by country and old district, species composition by sector, etc. Sector-wise annual catches for 4 years are presented in Table 1 of Agüero (this vol.) and the species composition by water-body type are presented in Table 1 below.

The statistical system developed under the BFRSS is mainly for estimating and monitoring the fish production of the country. However, parameters such as catch per unit of effort might be useful for fisheries management if this could be analyzed and reported.

Experiments in new approaches to the improved management of open-water fisheries project

It has been mentioned above that in this study, two types of survey and data collection programmes were planned. (1) baseline survey or frame survey and (2) sample survey to estimate desired parameter for evaluation and monitoring purpose. Data gathered and reported under the project are described below:

Baseline survey data

The frame survey includes among others, description and dimension of the *jalmahal*, number of fishing villages, number of fishermen, number of fishing units by gear type for the 12 *jalmahals* under the project.

Table 1. Species group-wise catch (t) in inland fisheries by type of environment (1986 - 1987).[a, b]

Species	River	Sundarban	Beel	Flood plain	Baor	Pond	Lake	Shrimp farm	Total	% of weight
Major carp	981	-	3,421	-	441	83,668	127	-	88,638	14.84
Other carp	1,039	-	4,313	1,415	-	3,473	154	-	10,394	1.74
Exotic carp	-	-	-	-	635	11,102	-	-	11,737	1.97
Catfish	3,743	-	8,487	4,080	-	2,057	232	-	18,599	3.11
Snake head	-	-	1,645	25,401	25	7,858	135	-	35,064	5.87
Live fish	138	-	160	13,362	2	5,872	-	-	19,534	3.27
Miscellaneous species	75,009	4,615	23,403	123,070	65	27,546	3,333	7,277	264,318	44.27
Hilsa	90,548	619	-	-	-	-	-	-	91,167	15.20
Big shrimp & prawn	1,903	480	-	-	-	-	-	10,341	12,724	2.13
Small shrimp & prawn	21,756	321	648	16,468	6	1,300	-	4,432	44,931	7.52
Total	195,117	6,035	42,077	183,796	1,174	142,876	3,981	22,050	597,106	100.00

a) DOF/BCAS (1987).

b) EDITORS' NOTE: Recent Statistics published by the Bangladesh Bureau of Statistics (Statistical Pocket Book 1989, p. 129) shows considerable differences in the value for the various species reported in this table (1986-87), although the overall total is the same.

Some base line data on the *jalmahals* under the project are shown in Table 2.

Fisheries and socioeconomics

In the 12 *jalmahals* under the project, data on the fishing activities (manpower, craft, gear, duration of fishing trips, catch by species and gear, length-weight data, price, etc.) were collected on sampling basis. As catch per unit effort is one of the most important parameter used for fisheries management purposes and is generally an indicator of fish abundance, an attempt is made to compare fisheries potential of 12 sites by using the catch per unit effort. The catch per unit of effort has been expressed as quantity of catch per fishing hour for each gear type and for all gear together for each fishery. The catch per unit of effort in the flowing waters are higher in two DOF managed fisheries namely Narisa-Padma and Padma-Jamuna Balobantha (see Table 2, A. Rahman this vol.) than those of other flowing waters. The information on the number of fishing units (effort), catch per unit of effort and total catch of the fisheries collected are not of much use at the moment except as base line information, but if these are continued, the time series data generated will be of much use for managing the open-water fisheries.

Problems and Remedies for Data Gathering

A primary requisite for conducting survey is the proper design of the survey (identification of population, sample unit, sample size), availability of sufficient trained manpower and logistic facilities such as transport, survey instrument, shelter at survey site, etc. Unless these needs are fulfilled, it is very difficult to conduct the survey efficiently and consequently, the accuracy of data will be reduced. Moreover other problems in field data collection from the fishermen and fish culturists in rural area exists. They are mostly illiterate and therefore it is very difficult for them to fully understand how they can benefit from responding to the

Table 2. Baseline data on jalmahals under the Project, "Experiments in New Approaches to the Improved Management of Open-water Fisheries in Bangladesh".[a]

Name of Jalmahal	Management type	Type of water body	Area (ha)	No. of fishermen	Fishing units
Narisha Padma Ujan Jala	DOF intensive	River	3,751	1,422	237
Padma Jamuna Balbant	DOF existing	River	9,018 (12,625)[b]	695	191
Maghna	NGO	River	23,684	10,607	1,592
Meghna-Nayabhan	Land Ministry	River	2,700	317	107
Baluhar Baor	DOF intensive	Baor	284	231	18
Kharincha Baor	Land Ministry	Baor	94	-	27
Shimulia Baor	NGO	Baor	24	-	24
Kannyadaha Baor	DOF existing	Baor	36	-	9
Arial Khan	DOF existing	Haor	81 (182)[b]	64	23
Roail Beel	NGO	Haor	145	-	28
Kanglar Haor	DOF intensive	Haor	72	211	29
Karcha Nadi	Land Ministry	Haor	80	-	33

a) BCAS (1987).
b) Figures in parenthesis show area during monsoon (flood period).

survey questionnaire. They think that it is a waste of time and energy to talk to the investigator as they will not be benefited by it. They sometimes become annoyed and misbehave with investigators. It is therefore the toughest work to collect data from fishing communities. Besides, it is also very difficult to get correct information from them. They think that they might be taxed or something against their interest will be done by the government if they provide the information. So it is their general tendency to hide facts and provide erroneous information. They have little trust in the government as the community is always oppressed and deprived.

Data collection/survey work from the rural fishing community and fish culturists is considered as the toughest and tedious work to an investigator and therefore, there is little job satisfaction for survey and data collection work to most of the investigators which in effect induces inaccuracy in data. So, unless extra facilities or remuneration are provided to the investigators, it is very difficult to get good work from them.

With proper design of the survey strategy and survey questionnaire, the accuracy of data can be increased to a great extent. Besides, for gathering correct information from the fishing community it is very important for an investigator first to make them aware of the objectives of the survey and make them understand that the survey is for their benefit. Experience has shown that an amicable approach and friendly relation with them may improve the situation to a great extent.

Personal judgement, perceptions and self awareness of the investigator regarding the data/information collected may help in obtaining correct data/information. And above all the aptitude and sincerity of the investigator are the most important factor for conducting a survey and collecting data efficiently and accurately.

Data Processing and Use of Computer

Data collected are to be processed, analyzed and reported properly so that proper use of data collected can be made. In Bangladesh the fisheries sector data processing system is still weak in respect to infrastructure facilities and skilled manpower. Computational facilities in Bangladesh Fisheries Department for fisheries data processing and analysis are very small. Computer facilities available in the fisheries sector and needs for additional facilities are described below:

Existing computational facilities and needs

For analysis and processing of data from ten sectors of fisheries under the BFRSS the following computer facilities are available.

Two Apple-II microcomputers which are fairly outdated. Most commercial software needed is developed for IBM-PC Compatibles. Most of the spares required for Apple-II are not available in Bangladesh. One of the two printers is completely outdated and its spare parts are out of production. Servicing facilities for these computers are not available locally. So it is necessary to replace these computers by IBM Compatibles. Besides, two units are insufficient to serve even 10% of the requirement. Only two sectors of 10 fisheries sectors are covered by computerization. At present there is no proper setup of computer personnel. The personnel working at present are not trained sufficiently. For full computerization of

the data processing and analysis under the BFRSS the following facilities are required:

a) Six microcomputers (IBM-PC or higher models)

b) Sufficient funds for maintenance and procurement of supplies

c) Manpower :

Senior System Analyst	1
System Analyst	2
Programmer	4
Data Entry Operator	4

Under the project "Experiments in New Approaches to the Improved Management of Open-water Fisheries" data on the following aspect are being processed and analysed by microcomputer.

(a) Socio-economic data

(b) Fishery biology and fishing technology

(c) Environmental data

Two PC-AT compatible micro-computer with a 20 MB hardcard are being used in this project. One computer is used for various project management activities while the other one is used for data entry programme development and data processing. Since a large volume of data (more than 100,000 data units) is received from field in every quarter of the year and they are to be processed within few days, it becomes difficult to perform all necessary analysis in such short time. To overcome this problem, one additional computer, one programmer and one computer operator are necessary. At present only one system analyst is available under the project.

Conclusion and Recommendations

The existing fisheries statistical system for collection analysis and reporting of data/information is still weak and insufficient to give full coverage of the complex fisheries system in Bangladesh for proper management and monitoring of the fisheries resources. Besides, the capacity of maintaining standard accuracy level of data to estimate the parameters with the existing manpower infrastructure and other facilities is not adequate. In order to make full coverage of all fisheries sectors under fisheries statistical system both biologically and geographically and to increase the reliability of the data the, present statistical system must be strengthened with sufficient trained manpower, infrastructure and other facilities. The following are the recommendations made for the improvement and strengthening of the fisheries statistical system in Bangladesh:

* National Fisheries census for collection of basic information (frame data on fishermen, fishing craft and gear, water areas, etc.) be undertaken.

* The existing Fisheries Survey System be strengthened with more manpower, transport, funds, etc.

* The Fisheries Investigators/Survey Officers be provided extra facilities and better remuneration to make the survey work more attractive.

* Data processing and analysis system be strengthened with more computers and skilled manpower.

* Special arrangement for printing and publishing of statistical reports be made so that the data/information are made available to the users in time.

* A fisheries data base be created with infrastructure and manpower facilities.

* Training of field level officers of the DOF on the objectives, ideology and method of implementation of the new fisheries management policy and survey and data collection from the fisheries.

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Panel Discussion

Dr. M. Mahbubur Rahman
Action Research Fellow
Centre on Integrated Rural Development for Asia and the Pacific (CIRDAP)

In the paper by Dr. Nuruzzaman, one would have expected an elaborated exposition of the data collection problems in rural fishing communities, particularly of socioeconomic data, since the paper has to deal more with the human resource components rather than the technical aspects of fisheries.

Hitherto, there are basically two concerns in the fisheries development:

* fisheries resource development per se (physical, biological, environmental, technological, etc.)

* development of fishing communities (human resources, people's participation, socioeconomic conditions, etc.)

Unfortunately, most of the concern has been on the first, and the concern for the second is only recent. A development approach to be effective and viable, should be holistic, integrated and interdisciplinary.

Social scientists do emphasize more the development of fishing communities for at least two reasons. First, since fisheries is a renewable resource, its judicial exploitation and management fully rest with the latter's perception and responsibilities. Secondly, the common property resources of the fisheries sector have to be conserved and protected by the fishermen themselves.

Moreover, for fulfillment of our basic needs in harmony with the environment and ecology, the development approach in the 1990s and beyond the year 2000 must "put the people first". Fishermen and fishing communities are no exceptions. Therefore, for promotion of their participation in their own development programs, more and more socioeconomic data are needed. Data collection techniques should be scientific and it should be a continuous process rather than a one-shot operation.

The process is difficult in the context of Bangladesh, but one can no longer afford to escape from this venture. To begin with, it is suggested that at the moment two teams each consisting of an Economist, a Sociologist/Anthropologist and a Statistician (with necessary support staff) may be deployed in two places - one at the Department of Fisheries (DOF) and the other at the Fisheries Research Institute (FRI). Their research work may be supported by the Bangladesh Agricultural Research Council (BARC) and/or donor agencies. Among others, their terms of reference may include:

* Survey and research on the various socioeconomic conditions of the fishing communities.

* Survey and research on the various socioeconomic conditions of the fishing communities.

* Devise and innovate data collection methods and data collection instruments, to be administered by the existing fisheries field extension officials.

* Maintain a socioeconomic data bank/profile and work as a clearing house both for the field extension officials and the policy makers and planners at the top.

* Organize training workshops for the field extension officials in several different places in the country to get them to realize the importance of socioeconomic data and the participation of the fishing communities in their programs, and appraise them with the new findings which would be useful for them.

* Assist in designing socioeconomic programmes for the fishermen and women to ameliorate their miserable conditions and bring them to participate in the mainstream of national development.

These activities as outlined above will be completed by the two teams but in two different ways. The FRI team will concentrate more on the research and the DOF one on the action research. Both the teams, however, would maintain work coordination with each other.

Dr. Mahabub Hossain
Director General
Bangladesh Institute of Development Studies (BIDS)

Inland fisheries of Bangladesh have declined by 6% during the last four years, although overall supply of fish increased by 2.6%. On the other hand, demand for fish is increasing at an annual rate of 4% or more. Therefore, price increase is inevitable. In fact, that is what is happening; the fish price increased by 15% per year as compared to foodgrain price of 8-9%, over the 1976-88 period.

As regards the share of income, pond and marine fisheries are dominated by upper income groups. The lower income groups share only inland capture fishery income. Therefore, the concern for inland fishery management is genuine.

Data requirements for management can be classified into two types. The first type of data will be for judging trends in the fisheries over time. These data are to be collected nationwide. Therefore, the number of variables have to be minimum. The second type of data are mostly on biology, ecology, economics and other conditions of the fishery system. There can be case studies and sample surveys, not necessarily country-wide and regular, for collecting these type of data. The present lack of some vital information in the sector is due to limited work done by scientists in this field.

Finally, with regard to the statistics of the Bangladesh Fisheries Resources Survey System (BFRSS) as amplified in Mr. Liaquat Ali's paper, there are some doubts on the methodology. The size of sample has to be much larger and specifications of variables need to be more exact.

Licensing *versus* Leasing System for Government Owned Fisheries *(Jalmahals)* in Bangladesh

Kamal Siddiqui
National Institute of Local Government
Agargaon, Dhaka
Bangladesh

Siddiqui, K. 1989. Licensing *versus* leasing system for government owned fisheries *(jalmahals)* in Bangladesh, p. 73-82. *In* M. Agüero, S. Huq, A.K.A. Rahman and M. Ahmed (eds.) Inland fisheries management in Bangladesh. Department of Fisheries, Dhaka, Bangladesh; Bangladesh Centre for Advanced Studies, Dhaka, Bangladesh; and International Center for Living Aquatic Resources Management, Manila, Philippines. 149 p.

Abstract

A distinction between licensing and leasing system for management of fisheries has been made in this paper. The paper discusses the overall management of fisheries in Bangladesh and cites the reasons of failure of the past policies of the government under the administration of both the Ministry of Lands and the Ministry of Fisheries and Livestock (MOFL) that were initiated from time to time. As regards policy changes from leasing to licensing, the paper concludes that a structural reform would be necessary in order to capture the potential benefits of fisheries through a licensing system.

Introduction

The importance of fish in alleviating protein malnutrition in Bangladesh can hardly be over emphasized. Fish is also a good source of minerals such as calcium, phosphorous and iron, and also includes some trace elements as well as vitamins and iodine.

Available information shows that protein intake in Bangladesh is deficient. Average per capita consumption of protein fell from 58 grams (g) in 1975-76 to 48 g in 1981-82. In this same period, about 77% of the total households were deficient in protein consumption (INFS 1977 and 1982). Although the latest situation is not documented by the statistical survey, indirect evidence points to a deteriorating trend.

This situation is undesirable not only because Bangladesh is climatically ideal for fish production, but also because the country offers a vast area of fishing grounds.

Table 1 shows the breakdown of different categories of inland fishing grounds in Bangladesh with their production per hectare (ha).

This table shows that the present yield/ha from inland fisheries is extremely low, suggesting that with proper fisheries management and development, there exists an immense potential for fish production in Bangladesh. There are, however, various factors which are holding back optimal utilization of the inland water bodies for fisheries, and hence contributing to the widening protein gap in the country. The major technical constraints are lack of adequate training, research, credits and other essential inputs such as boats, nets, and others; negative effects of insecticide use, flood control projects and other environmental pollution and paucity of physical facilities for fish hatchery, protection, stocking, storage, marketing, etc. However, no less important are the problems associated with ownership and management of water bodies. In fact, the two sets of constraints have been reinforcing one another for a long time to create the present impasse in the fisheries sector of the country.

Over-all Management of *Jalmahals*

One of the most crucial issues facing management of inland government fisheries today is the licensing *versus* leasing system which is the topic of this paper. However, in order to understand this issue more adequately, it would be in order to first discuss the controversy of administrative responsibilities among government agencies

Table 1. Area of inland fisheries and production in Bangladesh.[a]

Type of water bodies	Area in million ha	Production 1985-86	Yield/ha (kg)
1. Permanent water bodies	1.45	379,174	261
a) Rivers and estuaries	1.03	206,712	201
b) Haors, baors and beels	0.12	46,225	385
c) Artificial lake	0.07	2,433	35
d) Ponds and tanks	0.23	123,804	538
2. Seasonal water bodies (flooded for 4-5 months)	2.83	187,396	66
Total	4.28	566,570	132

a) DOF (1986).

with regard to government owned fisheries. There are at present about 10,000 *jalmahals* covering rivers and tributaries, estuaries, canals, *haors*, *baors* and *beels*. These are all owned by the government in the Ministry of Lands. In addition, there are about 1.7 million ponds and tanks in the country. About 100,000 of these are owned by the government in the Ministry of Lands, while the remaining are privately owned. Most of the seasonal water bodies are crop fields, which are privately owned. At present, all government water bodies with an area below 20 acres but above 3 acres are managed by *Upazila Parishad* (UZP), while those above 20 acres are directly managed by the Ministry of Lands. Government water bodies with area less than 3 acres have been made accessible to the entire public but these are to be managed by local Ministry of Lands officials.

Closely connected with the issue of leasing *versus* licensing is who would be responsible for managing whatever system (i.e., licensing or leasing) is adopted. Traditionally, the overall management responsibility for government owned water bodies was held by the Ministry of Lands/Revenue Department. Also, the Ministry of Lands/Revenue Department from the very outset had been managing both government land and water bodies along with other landed properties such as "hats", bazars, minor minerals, etc. Local functionaries of other departments and local government bodies did not have the experience and skill of administering this responsibility. Most important, land and water bodies should not be managed in isolation from one another, given the frequency of alluvion and dilluvion and the rapid changes in the course of open-water bodies in Bangladesh.

Transfer of management may initially give rise to legal complications in respect of disputes relating to *jalmahals* and their appeals, since it would amount to disrupting the quasi-judicial channel already in existence for this purpose. However, in 1980 the management of government owned water bodies was handed over to the Ministry of Fisheries and Livestock (MOFL). This experiment did not succeed.

Ultimately, in 1983 the management was reverted to the Ministry of Lands. Again in 1984, i.e. two years after the creation of UZP, the management of government owned water bodies with an area between 3 to 20 acres (i.e., 7 to 49 ha) was handed to the UZP on the ground that lease money from these water bodies would augment the UZP's own resources. However, this was to be a nine year arrangement. This period is now about to expire. Meanwhile, the Ministry of Lands has expressed the opinion that management of these water bodies should revert to it on several grounds. Firstly, owing to nepotism and other administrative bottlenecks, UZPs have failed to maximize revenues from these water bodies. Secondly, UZPs did not invest any money for their development. Thirdly, in respect of disputes regarding *jalmahals* managed by UZPs, the Ministry of Local Government Rural Development and Cooperative (MLGRD) was made the appelate authority by an administrative order. However, legally, the apellate quasi-judicial authorities are in order of ascendancy Additional Deputy Commissioner (Rev)/Commissioner/Bureau of Land Administration/ Ministry of Lands. As a result, many complications were created.

Finally, since revenue is the main concern of the UZP in managing the water bodies, the Ministry of Lands can transfer a part of the revenue raised from *jalmahals* to UZPs while retaining the management responsibility. Water bodies with area less than 2 acres were at first handed over to *Union Parishads* (UPs) for management,

but in 1987, it was decided that all water bodies with area less than 3 acres should be open to public access (and hence not to be leased out) and held under the day to day management of local officials of the Ministry of Lands (GOB 1987).

One of the main reasons why *jalmahals* under Revenue Department were not properly managed in the past was because the Deputy Commissioner/ Additional Deputy Commissioner (Revenue) as the custodians on behalf of the Ministry of Lands/Revenue Department, did not/could not supervise the revenue functionaries day to day management. This was due to the Deputy Commissioner's preoccupation with law and order, magistracy, development and protocol; and the Additional Deputy Commissioner's (Revenue) heavy load of work including management, reforms and disputes in respect of land, *jalmahals*, hats and bazars, minor minerals, etc. Recently, the *Upazila Parishad* has been entrusted with all development coordination within the district, which means that the Deputy Commissioner will now be able to devote much more attention to land and water management matters. With the reorganization of land administration now under implementation, there would be an Assistant Commissioner (Land) at the *upazila* level, two (instead of one at present), Additional Deputy Commissioners (Rev) at the District level (one for land disputes and one for land management and reforms), two (instead of one at present) Additional Commissioners at the Division level (one for disputes and one for management and reforms and two (instead of presently one) Boards at the headquarters level (one for disputes and one for management and reforms). Consequently, it is expected that in the new land administration set up, *jalmahal* management will improve.

However, much would depend on the motivation of the Ministry of Lands officials and the objectives set for them. If the main objective of *jalmahal* management is to increase fisheries development and improve the lot of the fishermen, and not simply revenue maximization, then several pre-conditions must be met. Firstly, the relevant officials will have to be committal. The role of proper recruitment and training as well as improvement of service conditions in this regard can hardly be minimized.

At the present moment, the reputation of most field officials of the Ministry of Lands (for that matter perhaps any Ministry) with respect to efficiency and financial integrity is questionable (Hossain 1963; Siddiqui 1981). As such, just because functionally Ministry of Lands is justified as the appropriate authority for over all management of *jalmahals*, this does not mean that there will be much improvement in *jalmahal* management with the Ministry of Lands in command. Indeed, unless the poor fishermen are highly organized and can exert a serious pressure on the management, mere emphasis on training, recruitment and improvement of service conditions will not suffice. Secondly, in any development-oriented management, the technical experts must be involved in a big way. In other words, although functional considerations justify that the over-all management of *jalmahals* lie with the Ministry of Lands, technical experts from MOFL must be accorded their due role in the management of *jalmahals* in order to solve the pressing technical constraints in the fisheries sector, as outlined earlier. This is not going to be an easy task in an administration bedeviled by inter-departmental jealousies, tendency for empire-building for financial and power corruption, lack of unified and integrated approach, etc.

Leasing *versus* Licensing

Under the lease system, the *jalmahals* are to be leased out to the highest bidder from among registered fishermen's cooperative societies for a specified period, one year for open fisheries and three years for closed fisheries, subject of course, to (a) the laws of the land regulating fish preservation and fishing and (b) the condition that no sub-leasing may be done. The period of lease is greater for closed fisheries because in these, usually "pile fishing" is carried out, which means that ideally no fishing is to be done in the first one to two years in order to develop and attract fish around the piling spots. The lease is to be conducted by the Additional Deputy Commissioner and his colleagues at the local level according to an approved calendar and through wide publicity. If the highest bidder among the registered fishermen cooperatives does not bid more than 25% above the last bid, then a fresh bid, where any organization or person may participate, will have to be organized. The lease system has been in action since 1950, that is, after ownership of all *jalmahals* were vested in the Revenue Department/Board of Revenue of the then East Pakistan Government under the East Bengal State Acquisition and Tenacy Act of 1950 (EBSATA). At that time, the lease system did not take into consideration registered fishermen cooperatives since these were generally absent, and in any case, the concern at that time was simply one of maximizing revenue.

The lease system was found undesirable for a number of reasons (Siddiqui 1981, 1982; Khan 1985). Firstly, the highest bidders are generally *jotdars* who did not belong to the fishermen community, and they usually sub-lease the *jalmahals* to richer sections of the fishing community. In the process, several layers of intermediaries are created, and the actual fishermen are subjected to "rack renting" and dependency relationship for their fishing rights (see Fig. 1, Agüero this vol.). Secondly, under this system of short term lease, there is a tendency to maximize profits to the neglect of investment for fisheries development. The intensive fishing induces over drainage or complete dewatering which contributes to shortage of water for irrigation. Thirdly, under such a system, the real fishermen can no longer eke out a decent living by fishing alone, so they resort to multiplicity in occupation which meant neglect to fishing. Finally, there had been innumerable litigations centered around *jalmahal* management and lease.

It was in this background of exploitation of the fishermen and under-development of the fisheries that the licensing system began to emerge as an alternative arrangement for managing the *jalmahals* in Bangladesh. Licensing system may simply mean distributing fishing rights to the actual fishermen. In this sense licensing system was first introduced in 1973 in which selling of fishery rights through auction were replaced by extending of fishing rights directly to the fishermen (GOB 1987)[a]. The salient features of this system as introduced in 1973 were as follows:

(1) All *jalmahals* were to be leased out in consultation with registered cooperatives of "real" fishermen. The primary societies of these cooperatives would receive priority in getting the lease.

(2) A "real" fisherman was one whose livelihood depended mainly on fish catching and selling. A fishermen's society having members who were not real fishermen was not eligible to obtain lease of *jalmahals*.

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a EDITORS' NOTE: Later, in 1986 the government considered restrictive Licensing system as a major instrument for implementing a new fisheries management policy (NFMP) for inland open-water fisheries (see Agüero this vol. and A. Rahman this vol.).

(3) The lease would be for a period of one year in case of open fisheries and normally for three years in case of closed fisheries. However, closed fisheries could be leased out for more than 3 years at a time if the lessee society, in writing, accepted the responsibility for the *jalmahal's* development work.

(4) In order to lease out *jalmahals* to real fishermen, there would be two committees, one at Sub-division level (this tier no longer exists) and the other at District level headed respectively by Sub-Divisional Officer and Additional Deputy Commissioner (Rev); other members of the District Committee were one Member of Parliament, Asst. Registrar of Cooperative Societies, District Fishery Officer, two representatives from among fishermen, two representatives from among farmers and Revenue Deputy Collector (Member-Secretary). Similarly, Sub-Divisional Cooperative Officer, Sub-Divisional Fisheries Officer, two representatives from among fishermen, two representatives from among farmers and Revenue Circle Officer (Member-Secretary) were made members of the Sub-Divisional Committee. The Sub-Divisional Committee would do the actual work of identifying real fishermen cooperatives and leasing out the *jalmahals* to them, while the District Committee would (a) hear appeals against decisions of the Sub-Divisional Committee and (b) lease out those *jalmahals* to fishermen cooperatives which covered more than one Sub-Division. In case of *jalmahals* extending beyond one District, the Ministry of Lands would take the necessary decision.

(5) The lease money was to be fixed at 10% above the average annual income from a *jalmahal* during the last three years or simply last year's income (which ever is higher).

(6) If there was no real fishermen cooperative society available, a *jalmahal* could be leased out to the highest bidder.

This system continued upto 1976, when "restricted leasing" i.e. leasing to the highest bidder among the registered fishermen cooperatives was introduced. The licensing system failed for the following reasons (Siddiqui 1982):

(a) Despite the legal niceties, the registered fishermen cooperatives were completely dominated by the non-fishermen traders, *jotdars* and political touts at the apex and other federating levels and by the richest among the fishermen at the primary society level.

(b) The Sub-Divisional/District Committees did not and could not function properly. Political interference, corruption and arbitrariness, played their part in sabotaging the new arrangement. Consequently, all the vices that existed under the leasing system (discussed above) continued unabated under the new system. In addition, government was deprived of the revenue from *jalmahals*.

In 1980, the overall responsibility for managing *jalmahals* was transferred to the MOFL, who operated under two systems, namely (a) restricted leasing i.e., among the registered cooperative societies, and (b) direct negotiation with organizations/individuals. In 1983, management responsibility came back to the Ministry of Lands, who continued with the above two arrangements. It hardly needs to be emphasized that both these arrangements acted against equity and production considerations. Restricted lease meant lease within a coterie of vested interest groups given that all the so-called registered cooperatives of fishermen had long ago degenerated into closed clubs

of "water lords", touts and big traders. Direct negotiation and allowing dispute hearing at the Ministry level meant access by the richest and the powerful only, often through use of influence and money mediated by the lawyers.

These problems of the existing system of lease were examined by the Land Reforms Committee, 1983 (GOB 1983). The main recommendations of this Committee with respect to *jalmahals* were as follows:[a]

(1) The main aim of *jalmahal* management should not be the maximization of revenue, rather *jalmahals* should be utilized for the welfare of the genuine and poor fishermen.

(2) The *jalmahals* which are now covered by specific projects for pisciculture should be retained by government. However, genuine fishermen should be employed to catch fish in these *jalmahals*. Half of the sale proceeds of fish should be paid to fishermen and the rest may be utilized for operation, maintenance and development of fisheries.

(3) *jalmahals* which are not covered by specific projects should be leased out to assetless groups for a term of five years at nominal rent.

(4) In the case of rivers, all fishermen should be allowed to fish subject to legal restrictions for protection of fish.

(5) Fisheries transferred to *Union Parishads* and *pourashavas* (i.e. ponds with less than 2 acres of water area) should remain with them. These should be leased out to landless groups for a period of five years at a nominal rent of one percent of net income.

In 1984, *jalmahals* with area between 3 to 20 acres were transferred to UZPs who were also required to follow the restricted lease system. In the absence of any survey, it is difficult to ascertain whether UZPs followed a restricted or unrestricted lease system but given their basic concern with lease money, it is quite obvious that UZPs did not involve themselves with ensuring the rights of the common fishermen. In 1987, a "new *jalmahal* policy" was adopted by the Ministry of Lands under which all *jalmahals* would be leased out to groups of only "genuine" fishermen in phases. As a beginning, 10 *jalmahals* were taken up under the new policy in 1987. In 1988, another 140 *jalmahals* were leased out to groups of "genuine" fishermen. This time, the lead organizations involved in the selection of genuine fishermen from among the fishermen was the *Jatiya Matshyajibi Samity* (National Fishermen Association), and not the fishermen cooperative societies. This, along with *upazila* level Committees, was to identify "genuine" fishermen and organize them into teams; provide them with licenses of fishing and marketing rights; arrange for credits, training and inputs; inspect *jalmahals* regularly; and scrutinize, approve and help implement fishermen groups' annual and long term development plans. The *Upazila* Committee consists of 8 members, with the *Upazila Nirbahi* Officer (UNO) as Chairman, *Upazila* Fishery Officer as member-secretary. Other members are the *Upazila* Revenue Officer, the *Upazila* Cooperative Officer, the representative of Bangladesh Krishni Bank (BKB) or lead bank, the Bangladesh Rural

a EDITORS' NOTE: The government declared a new fisheries management policy (NFMP) in 1986, which would gradually replace the traditional Leasing system by a Licensing system to genuine fishermen. Under the NFMP few jalmahals were transfered (1986-87) to MOFL/DOF for administering selective licensing system (see A. Rahman this vol.), although the Ministry of Lands held the responsibility of administering the lease or license management in all other government water bodies.

Development Board (BRDB) representative and two local representatives of *Jatiya Matshyajibi Samity*. Above the *Upazila* Committee lies the District Committee which is responsible mainly for supervision of the *Upazila* Committee's work and for carrying out the decisions of the Central Committee. Other functions include annual internal evaluation, advising the Central Coordination Committee, removing bottlenecks faced by the *Upazila* Committee, etc. The District Committee is headed by the Deputy commissioner and the member-secretary is the District Fisheries Officer. Other members are ADC (Rev), District Cooperative Officer, Regional Manager of BKB, Project Director, BRDB and two district level representatives of the *Jatiya Matshyajibi Samity*.

At the national level is the Central *Jalmahal* Coordinating Committee headed by Secretary, Ministry of Lands; Joint Secretary, MOFL is the Member- Secretary. Other members are Joint Secretary, Local Government Division, D.G., BRDB, Managing Director, BKB, Registrar Cooperative Societies, Land Reforms Commissioner and President and General Secretary of *Jatiya Matshyajibi Samity*. Their functions include implementation of the new *jalmahal* policy and improvement of the same in the light of practical experience and providing directives to District and *Upazila* Committees. The term of lease of *jalmahals* to the organized groups of genuine fishermen would be one year for open fisheries and 3 years for closed fisheries. The lease money would be fixed at 10% above last 3 years average revenue from the *jalmahal* concerned. Meanwhile, in 1988, about 14,000 ponds and tanks have been legally handed over to the Grameen Bank and Bangladesh Rural Development Board by the Ministry of Lands on a long term basis, subject to the condition that landless groups organized by them will develop these as fisheries and earn their livelihood by catching and selling fish from these ponds and tanks. Once in operation, this arrangement will also constitute "licensing" in the sense that only organized landless groups will be allowed to fish in these water bodies. It needs to be pointed out here that the landless people to be organized will not be traditional fishermen. It is too early to say how this programme will fare in the long run since it is still in preparatory stage.

As may be noted, there is basically no difference between the licensing systems of 1973 and 1987. However, in 1973, there was no Central Coordination Committee and implementation was in one go rather than in phases. There are no elected representatives and farmers representatives in the 1987 Committees. Registered Cooperatives of fishermen were involved in 1973, while in 1987 *Jatiya Matshyajibi Samity* is the only organizations involved in the process of identifying and organizing genuine fishermen groups from among the fishermen. It needs to be pointed out here that this organization does not as yet have branches all over the country, and it seems that it is not at all immune from political pressure and pressures from rival fishermen cooperative organizations. It is, therefore, to be seen whether or not this would remain an organization of genuine fishermen in the long run, when expansion takes place and pressures from vested interest groups increase. A recent evaluation of the 10 *jalmahals* taken up under the new *jalmahal* policy in 1987 rightly points out, the success of the new *jalmahal* policy will depend mainly on the identification and organization of the genuine fishermen. The evaluation report (IMED 1988) reveals the following problems in the implementation of the new policy:

(a) The list of genuine fishermen prepared in respect of the 10 *jalmahals* is not

without lapses, and unless genuine local peoples representatives are involved in the process of selection, lapses would multiply in future.

(b) There exists a number of rival organizations of fishermen. These are creating many impediments in implementing the new policy.

(c) Non-fishermen and influential traders, *jotdars* and touts often harass genuine fishermen during the fishing season. The law and order authorities have taken no action to prevent these mischiefs. Similarly, in the absence of clear cut boundaries of *jalmahals*, clashes often occur between licensed and unlicensed fishermen.

(d) For various constraints, members of the *Upazila* and District Committees have not been able to discharge their inspection and supervision functions. Consequently, illegal and forcible fishing by unlicensed fishermen from the *jalmahals* could not be prevented.

(e) So far, the *Upazila* and District Committees could not/did not contribute anything towards handling distributions marketing, extension, training, etc. by way of developing these ten *jalmahals*.

Concluding Remarks

The above picture is rather dismal, and is bound to appear even darker when the 140 *jalmahals* (aside from those under the experimental project of DOF) taken up under the new policy in 1988 are evaluated. During the last forty years, we have swung like a pendulum between leasing and licensing system. Both have been tried, both have miserably failed to solve the basic problem confronting fishermen and fisheries development. Therefore, there is really no choice between licensing and leasing systems in the concrete conditions of Bangladesh, although on the face of it, licensing system appears to be "pro-fishermen" and leasing system seems to yield more revenue for the government.

The real problem is much more deeply seated; we have a society in which the extremely anti-productive and parasitical rural and urban rich are dominant. They control all the power structures through various dependency relationships and they effectively use these in pursuit of their anti-productive activities. Consequently, the objective of production and equity based development, whether in *jalmahals* or land, or in any other resource, cannot be pursued adequately unless the economic and political stranglehold of these classes is dismantled through drastic land and asset reforms.

This calls for political mobilization of the rural and urban poor including genuine fishermen. How this will come about is beyond the scope of this paper. But one thing is certain: leasing, which is a blatant form of anti-productive use of the fisheries conforms more closely to the existing socioeconomic structure, whereas licensing system is bound to degenerate into all the vices of the leasing system within the existing socioeconomic structure. On the other hand, a licensing system has the potential to fulfill the objectives of production and equity in the fisheries sector only after the basic structural reforms have been carried out in Bangladesh. Under the prevailing conditions in Bangladesh, leasing *versus* licensing sounds like the devil versus the deep sea.

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Licensing *versus* Leasing System for Fishing Access

Syed Ali Naqi
Department of Sociology
Dhaka University, Dhaka
Bangladesh

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Abstract

In this paper, an analysis is made of the two alternative access systems - licensing and leasing - used for the allocation of inland fishing grounds in Bangladesh. The fishery management problems in terms of legal, economic and institutional characteristics of both systems are highlighted. Under the New Fishery Management Policy (NFMP), the leasing system would be gradually replaced by a licensing system i.e., groups of fishermen would be issued licences. Present experimentation with this policy has already demonstrated positive impact on fishermen as the target group. In experimental sites the exploitation by leaseholders has been eliminated and fishermen are enjoying more benefits than before. Still, pressure from local power groups and elite interventions from behind the scene could not be counter-balanced through fishermen organizations (cooperatives), which are still weak and ineffective.

Marketing of fish is not well organized. In most fisheries, fish production is marketed privately. This marketing system, does not guarantee fair prices to fishermen because of middlemen's power to depress price levels at the ex-vessel level. The credit situation in both licensing and leasing systems is discouraging and fishermen complain about credit scarcity. Credits that are available cannot easily be channeled to their intended recipients because of complicated procedures.

Introduction

The discussion in this paper centers around fishery management problems under two divergent systems: licensing and leasing. The relative benefits to be derived and social costs involved under alternative management system demand an investigation of the past and present situation in terms of legal, economic, and institutional and social characteristics of either system, and the distribution of socioeconomic and political power in rural society. This paper analyzes these and the role of middlemen both in the fishing access as well as in the market for sale of the catch.

To better understand management problems under the two systems mentioned above, a comparative analysis has been made based on data generated periodically by the Monitoring Team from 12 sites under four different management systems: 3 under the Department of Fisheries (DOF) intensive management, 3 under DOF semi-intensive management (with existing resources), 3 under NGO management and 3 under the Ministry of Lands "middlemen management" (see A. Rahman this vol.). The management under DOF and NGO use a licensing mechanism while that under the Ministry of Lands involves leasing to highest bidders.

Tenure of Water Bodies

Inland water bodies (*beel*, *baors*, *haors*, rivers) are public property and fall under the responsibility of the Ministry of Lands (formerly Ministry of Land Reform and Revenue). In the past, some closed and open-water bodies (rivers and *beels*) belonged to the *zamindar*, while others were government property. Fishermen used to get fishing access by paying revenue either to the landlords or to the lease holders. At present, ownership of all fishing grounds rests with the Ministry of Lands.

Under the prevailing policy, the Ministry leases out defined water areas through auctions for varying periods and against the payment of a lease fee to:

* private entrepreneurs (one to three years lease period)
* local cooperatives (up to five years)
* government agencies (for longer periods, up to 30 years)

Limitations of leasing procedure

Traditionally, the fishing grounds were leased out by the Ministry of Land Administration & Land Reform (now Ministry of Lands) for terms of one or three years depending on the environment e.g., flowing rivers and *baors* or *haors* etc. As a common practice, a prior fixation of the bid value was made by the Ministry before putting the water bodies for public biddings through open auctions. In almost 100% of the cases the bids were undervalued and usually obtained by politically or economically influential people who could maintain a close link with government agencies or personnels in the area. The tricks to keep base values low has been to restrict access to the auction to the genuine fishermen by prearranging the lease fee among the interested parties. The actual fishermen either individually or in a group were rarely lucky enough to secure any of these bids. However it should not be forgotten that the hard task of actually harvesting of the fish resources was left to the extremely poor fishermen who could hardly enjoy the benefits of common property. Much of the benefits of inland fisheries was enjoyed by local elites (political, business) (see A. Rahman this vol.).

Toward a new policy

Considering the limitations of the old policy, GOB has recently (1986) decided to implement a new fishery management policy over the next decade. Under this policy all inland fisheries are to be turned over to DOF for implementation of the NFMP. Committees at *Upazila*, district and national level are to register the genuine fishermen and issue them licences. Only licence holders are then allowed to fish. The licence fees are calibrated to allow eventual recovery of GOB investment and operating expenditures while maximizing benefits to fishermen. In order to implement the new policy, DOF has undertaken a pilot project to experiment with alternative forms of management involving a limited number of water bodies. The two major objectives of this new management system are:

* to try and divert benefits arising out of inland water fishing to the actual fishermen from the middlemen who currently derive most benefit from the fishery resources.

* to take into account the sustainability factor in already depleted inland waters, hopefully reverse the current trend and maintain a high level of productivity.

It seems, however, that adoption of the new policy is strongly opposed by the power groups, i.e. large land owners, middlemen and other influential people among the rural elites, which traditionally exploit inland waters. In particular, the power groups who have for generations, exploited the larger flood plains and *beels* have put strong resistance and this dispute remains to be settled.

Organization and Management of Inland Fisheries Under the Traditional Leasing System

Until the present, the exploitation of some inland fisheries such as ox-bow lakes, *baors* etc. for fishery purposes has been organized with some variation in three basic models:

i) exploitation by local cooperatives;

ii)exploitation by private entrepreneurs;

iii)exploitation by GOB agencies such as DOF, District Rural Development Board.

The lakes which are under the responsibility of the Ministry of Lands were leased out for short (in case of private lessors), medium (for cooperatives) and longer periods (for GOB agencies) through auctions.

Fishery cooperatives were formed by local power groups and middlemen who more or less dictated the terms of management and remunerated the involved fishermen in a minimal way. Their power usually stemmed from their control of marketing and the fact that many of the fishermen were indebted to them. These so-called cooperatives were, in practical terms, not different from private enterprises.

Private entrepreneurs employ a similar approach to perpetuate exploitation, but in some cases actually provide production inputs, as fingerlings and other efforts like deweeding. In privately leased lakes/*baors*, it appears that some 15% of the catches are distributed in kind to various influential parties on a regular basis.

The relatively short lease periods granted to private lessees and local cooperatives discourage investment and rational management of the fisheries. Since the common objective of the lease holder was usually to maximize short-term returns, exploitation practice was mostly to the detriment of the sustainability of fish resources. This policy, therefore, contributes little to rational and long-term fishery management.

The lakes under DOF responsibility are supposed to be stocked with fingerlings purchased with DOF funds and provided with hatchlings from the government fish seed farms. Actually only few lakes/*baors* leased out to DOF are stocked regularly, and even then the fingerlings are often insufficient in number and size. DOF is also in charge of marketing the catch of the lakes/*baors* under its responsibility. The fishermen who catch the fish are to receive 40% of the revenues, while the remaining 60% are recycled into GOB treasury funds. The 40:60 share arrangement is widely opposed by the fishermen who feel their share to be too low.

Licensing System in Flowing Rivers Under NFMP and Some Problems

DOF is implementing a licensing system in two of the flowing rivers (see A. Rahman this vol.). Padma-Jamuna Balbant fishery is under DOF licensing management with existing resources. The fishery falls in three *Upazilas*:

a) Harirampur and Sibaloy *Upazila*

b) Faridpur *Upazila*

c) Goalando *Upazila*

Fishing licences have been issued from three *Upazila* Fishery Officers. The fishermen and their groups are listed and approved by the *Upazila* and District Fisheries Management Coordination Committee.

The Narisha-Padma fishery has been under intensive DOF management. Identification of individual fishermen and their groups has been done by the relevant *Upazila* and District Coordination Committee for implementation of the new fisheries management policy. The fishing groups are based on the type of fishing gears used by the groups.

The Meghna fishery was supposed to be under the management of an NGO called *Proshika Manobik Unnayan Kendra* (PROSHIKA). However the Additional Deputy Commissioner (Revenue) Barisal has leased it out to a private businessman. The lease holder has reportedly subdivided the fishery into segments and subleased to sub-lessees for a higher value. Naturally the fishermen have to pay a higher rent for fishing.

Sub-lessees and their agents collect taxes (rents) from actual fishermen and fishing units entering their respective water segments. Fishing boats in a particular segment are given special identification marking by the sub-lessees. Boats with one type of marking are not allowed to operate in other segments. Boats are, however, allowed to pass through one segment to other on payment of transit fees to the sub-lessees. This type of leasing and sub-leasing system does not bring expected benefit to fishermen who are on the contrary exploited by the lessee, sub-lessee and local influential people.

In the fisheries where a licensing system has been implemented, it has proved to be quite successful and by all accounts quite popular with the fishermen. However a number of secondary problems have arisen for which methods need to be evolved for their resolution. Important among these are discussed below:

Conflicts over particular patches of water within a given fishery

In the past, the *ijaradars* or their representatives in the ground were the arbitrator and sole decider and could resolve conflicts between two fishermen groups who intended to fish in the same location. However under the licensing system every licensed fishermen (or group) has equal right to fish anywhere within the limits of the *jalmahal*. Fishermen in such cases have to come to the relevant UFO which is not a convenient arrangement. Examples of such conflicts have been noted in the Padma-Jamuna fishery.

Non-uniformity of licence fee

The Padma-Jamuna fishery falls within three different districts (Manikganj, Faridpur and Rajbari) whose relevant *Upazila* Management Committee and the District Fishery Officer (DFO) have set their own rates of fees for each type of gear. However once a fisherman (or group) obtains a licence, he (they) is (are) at liberty to fish anywhere within the entire fishery. This causes resentment among fishermen having licences from the DFO. They may be paying higher fees for the same gear to fish within the same fishery.

Non-renewal of licences

It has been observed that many of the fishing units which were issued licences in 1393 (1986-87) did not renew them in 1394 (1987-88). For example, in Padma-Jamuna fishery out of 139 licences issued in 1393, only 39 had been renewed in 1394. On enquiry the fishermen were found to admit that lack of credit and also non-availability of particular fishes are the main reasons for non renewal of licences. For example, the operators of *jogot ber* (seine net) who catch *pangas* fish stated that there were no *pangas* in their fishery this year. So they did not renew licences. In other instances, the fishermen delay until the last minute before renewing licences. Thus they renew licences just when they see fishing activities begin.

Unlicensed and illegal fishing

In the past, the *ijaradar* and his employees ensured that no untaxed fishing occur in their fisheries. Some illegal fishing practices (e.g., using fixed engines) were allowed but on payment of an appropriate fee. However, after the new licensing system has been introduced fishing activities practiced by unlicensed fishermen (often migratory fishermen from outside the district) or illegal fishing practices (e.g., fixed engines) could not be checked. For example, in the Padma-Jamuna fishery at least 15 fixed engines *(thoga jals)* were seen to operate during the dry season. It is physically impossible for the lone *Upazila* Fishery Officer (UFO) to police this and similar illegal activity. Moreover, illegal fishing takes place under the protection of powerful local elite who allegedly share the benefits with the owners of the gear, who happen to be outsiders.

Also, in the Narisha-Padma fishery, a number of migratory and local unlicensed fishermen are currently conducting fishing operations, some of whom seem to be unaware of the introduction of a licensing system. One group of such migratory fishermen stated that they were waiting for the *ijaradar* to come and collect toll from them. In the case of Kanglar *haor*, however, the local licensed fishermen have organized themselves into a group (committee) with the assistance of the DFO and have been able to control unlicensed fishing by placing their own guards on the fishing ground and organizing scheduled fishing activities. They also introduced a system of allowing subsistence fishermen to fish at the periphery of

the water body (up to waist high water only) against fees of Tk. 10/day per fisherman.

It is not possible for the UFOs to carry out such policing over a big stretch of water without appropriate facilities. It can be done by the licensed fishermen if they could be properly motivated as has been done in Kanglar *haor*.

General Problems in the Inland Fishery

Access to water bodies by different fishermen categories

In the social context of rural Bangladesh, surrounding the inland water bodies, the following three categories of fishermen have access to fishing either legally or illegally:

(a) full-time fishermen;

(b) part-time fishermen;

(c) occasional fishermen (landless and marginal farmers).

These groups have been identified on the basis of the following indicators:

(a) source of income;

(b) fishing skill and knowledge of aquatic environment;

(c) assets (land);

(d) occupational & regional mobility;

(e) localization.

The full-time professional fishermen have developed professional skills and through generations, have acquired adequate knowledge about the aquatic environment. Full-time fishermen, according to the selection criteria, are those who fulfill the following requirement:

* fishing as major source of income
* do not perform farming activities or if done, only at subsistence level
* possess well developed fishing skills and experience
* little occupational mobility and highly localized

Since different categories of fishermen have access to fishing, conflict ensues to gain more economic benefits out of fishing. There has been also occasional conflict between fishermen and agriculturists who try to use *baor* water for irrigation and reclaim more lands for cultivation. Several groups are in a spree of competition for a substantive gain out of the use of these lakes (*haors/baors*).

(1) full-time, part-time and occasional fishermen for fishing;

(2) fishermen, local power groups and GOB agencies for financial benefits from fishing;

(3) the above and the local farming population, which use the water bodies for non-fishing purposes such as irrigation, jute retting and land reclamation.

Group formation

Under the NFMP, effectively the only social organization of fishermen (in the sense that a common goal and agreed modus operandi/share system exists and participants take decisions collectively which have effectively emerged as consequence of the new management policy) are the *kotchal* and *kumar* groups formed to obtain licences and facilitate fishing.

Since fishermen in all 12 sites have not been effectively organized for group activities, existing cooperatives formed by them in the project area remain at a rudimentary stage. For the organization of the beneficial groups of fishermen, NGO experiences in fishery-related assistance

have been far less satisfactory. However in some of this managed projects, NGOs had partially motivated fishermen to form functional groups. CARITAS and PROSHIKA may be cited as examples in Simulia and Roail *beel* respectively. CARITAS was able to eliminate non-fishermen from the Simulia Fishermen Cooperative. Nevertheless, neither PROSHIKA nor CARITAS could take a successful lead in group formation.

The informal groups of *kochal* and *kumar* remain the basic functional units of fishermen since there has been a growing necessity of group fishing. The cohesion in the organization of these groups is not guaranteed as fishermen seasonally participate in fishing activities. This situation does not help in maximizing socioeconomic benefits for the fishermen.

The following constraints toward the development of a viable fishermen's cooperative have been identified.

* lack of motivation among the group members
* communication gap among the group members
* atomistic nature of fishermen cooperatives
* the pressure of local power groups
* lack of monitoring and evaluation of the work of the cooperatives
* lack of initial funds
* lack of leadership

Owing to the presence of constraints mentioned above, most of the fishermen cooperatives remain organizationally loose and seem to be atomistic in nature. Fishermen in Karincha *baor* are the only exception, because enthusiastic local leadership has motivated the fishermen to establish a strong organizational base.

The formation of women's groups has not been emphasized in any of the 12 sites. This method could be used to involve women in income generating activities through their support services to the profession (such as net weaving and net repairing).

The full-time fishermen live in small lake-side settlements or they are migrants in open water bodies (rivers). Some relevant facts of their communal organization could be identified:

(1) There is no formal leadership structure.

(2) Leadership of any kind is usually based on economic affluence and access to resources.

External intervention and conflict

It is likely that local elites try to participate in the financial benefits created by the different beneficiary groups the moment these benefits become significant.To counteract this, only two factors promise a certain possibility:

* the building up of self-reliant and strong organizational structure

* long term monitoring by an independent group not having vested interest in the exploitation of aquatic resources in the project area

There appears to exist a certain level of collaboration between GOB officials and the local power groups who effectively benefit from the exploitation of fishery resources at present. The present licensing system would meet, at least initially, opposition from this sector.

Due to the nature of the credit arrangements, fish marketing can not be viewed in isolation from credit. The sale proceeds received by the fishermen are adjusted for advance payments made by the *aratdars*.

Fish production is marketed privately through a middlemen. The *aratdars* may either transact these business directly with fishermen or through their agents known as *farias* who are also middlemen. This depends on the communication facilities. The fishermen bring the fish to *aratdars* if communication is good either by bus or truck. The *paiker* (wholesalers) make purchases through *aratdar.*

Marketing and middlemen

For marketing of the catch realized by the fishermen, three marketing outlets are at present operating in Bangladesh inland fishery

* sales to small-scale local fish vendors for direct marketing in the surrounding areas
* auctioning to medium and large scale private wholesalers
* sales to Bangladesh Fisheries Development Corporation (BFDC)

Marketing is organized and operated in Baluhar *haor* in the following manner:

After being landed, the catch is weighed, registered and stored by the fishermen in the chill-rooms provided by the Baluhar *baor* Project. Decisions on which of the market outlets to use are made by the marketing sub-committee of the fishermen's association. This market outlet guarantees minimum prices to fishermen and provides insurance against concerted efforts by local middlemen to depress price levels by exercising a monopoly on large-scale marketing. This ideal condition does not prevail all over inland fisheries. In most of the fisheries fish production is marketed privately in surrounding areas (river ports, districts and *Upazila* headquarters). The marketing of higher value carps in large quantity is controlled by local middlemen called *nikari.*

In Kanglar *haor*, the catch is sold at the *beel* site immediately after the harvest through open auction. Fish traders compete for fish through open bidding. Once the auction is over, the bid winner pays the amount in cash and transports the fish to market centers. The fish traders are normally retailers or wholesalers in the local or regional market. Sometimes some of the member fishermen engage in fish trade as part-time business when they have no fishing schedule.

The fishermen sometimes directly bring the catch to the *aratdar* instead of selling the catch on their boats if the quantity of fish is more and catch size is big. *Nikaris* also purchase fish at boat sites when quantity is large. Since they know the market situation, they ferry the fish to the district headquarters (Jessore, Jhenaidah, etc). The catches are auctioned at the *arat* and *aratdars*, who are middlemen, collect only commissions without investing any money in the fish transaction.

The *aratdar's* margin is fixed and well known and works out at approximately 6% of the sale in cash. The sale is against *dadon* and 3% in a free market situation. Though *dadon* is initiated prior to catching of the fish, the price of fish is not negotiated in advance, so the fishermen are directly exposed to market fluctuations. Our observations suggest that retailing, wholesaling (i.e. trade) and transportation margin stand between 15% to 20%. The fishermen therefore receive about 80% of the price paid by the ultimate consumers. In case of on-boat sale, the fishermen's bargaining power is comparatively weaker. If the carps are small in size, they find a market in the village at a reasonable price. If they are big enough and large in quantity, *nikaris* or fishermen themselves hire a rickshaw or cart to ferry them to district headquarters for sale. Often buyers whose

number is very few make an implicit arrangement among themselves and buy the fish auction at a very low price. The fishermen in this situation lose some of the potential benefits.

Credit situation

In both licensing and leasing systems, institutional resources of credit for fisherfolks would have come through a local branch of the Bangladesh Krishi Bank (BKB). Because of lack of collateral and the lengthy complicated procedures involved, it is nevertheless almost impossible for an individual family to receive credit. The factual gap between credit institutions and the credit needs is frequently used by middlemen who provide the collateral and take up credit for a group, e.g., a cooperative. Final disbursement and repayment is then determined and controlled by the middlemen to their advantage.

In the absence of functioning credit systems the poorer fishermen often resort to local money lenders for financing needs and pay substantially higher interest. However the traditional institution of money lender is a highly ambivalent one. While at the one hand he certainly squeezes disproportionately from his client, sometimes keeping him in continue indebtedness, he also knows the credit worthiness of every individual and is ready to provide the miniscule amounts required on short notice and without bureaucratic complications. It is doubtful whether any type of institutionalized credit could ever take up this function (last but not least for the immense administrative costs this would imply). The only feasible way for a bank to provide credit according to the need-structure of small producers would be through a fair, non-profit mechanism to take over the on-lending on an appropriate scale of larger sums provided by the bank.

Conclusion and Suggestions

In view of the problems stated above, the present paper brings forth the following suggestions and recommendations:

* All inland fisheries are to be gradually turned over from leasing to licensing system under the effective supervision of DOF. Only licence holders would then be allowed to fish.

* The licence fees are to be calibrated to allow ultimately the recovery of GOB investment and operating expenditure while maximizing benefits to fishermen. This would also imply reassessment of the present DOF practice to keep 60% of the sale proceeds and to distribute only 40% to the fishermen.

* To counter-balance the local power groups viable fishermen association need to be organized by NGO with initial funding from BKB.

* Credit is to be provided by BKB without collateral but linked to the renewal of licences.

* BFDC network has to be gradually spread over wide area with requisite number of chill rooms. It is to grow to take over-marketing operation in order to eliminate middlemen. BFDC would provide a counter-balance against concerted efforts by local middlemen to depress price levels.

* Fishermen's cooperatives need to be strengthened and DOF's management is to be extended to the marketing channel, so that the benefits derived by the fishermen could be increased.

* Fishermen cooperatives should be expanded to include other beneficiary groups like:

a) groups of fingerling producers

b) groups of small scale fish vendors

c) net making and net repairing groups of women

* The different beneficiary groups mentioned above should build their own organizational structure independent of each other. But they would interact within the general framework of fishermen's cooperatives for their common goal (economic welfare). The fishermen's association would function as a service cooperative for input acquisition and sales of the produce.

* Finally, the monitoring and collection of information for future action and policy should be more effective.

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Panel Discussion

Mr. M.A. Samad
Director General
Implementation, Monitoring and Evaluation Department (IMED)

The papers on "Licensing *versus* Leasing System for Fishing Access" are both useful and complementary. The land reform committee of 1983, set two main objectives for fisheries:

* increase fish production

* increase welfare of fishermen

Experience has shown that existing leasing systems cannot achieve simultaneously the objectives of maximizing production, conserving fish resources and increasing the welfare of fishermen. Furthermore, mere institutional reforms cannot guarantee the attainment of these objectives.

Evaluation of ten *jalmahals* managed by the Department of Fisheries (DOF), under the guidelines of New Fisheries Management Policy (NFMP), showed that licensing system is more popular with the fishermen and they see more benefits than under the leasing system. With the licensing system *ijaradars* have been eliminated and the fishermen can eat some of their catch.

However, licensing is only a first step. The DOF must come up with programmes of development, supply of inputs, extension services, training of fishermen and fish-workers, and marketing.

Although banks are supposed to provide credit in the fishery sector, observation shows that credit is seldom available to poor fishermen and they are still dependent on middlemen for capital.

On the other hand, fishing is a seasonal activity. The fishermen's lot cannot be improved only by improving the fisheries. The fishermen should be involved in programs of non-fishing activities. Human resources development programmes also need to be undertaken for the welfare of the fishermen community.

Dr. Qazi Faruque Ahmed
Executive Director
Proshika Manobik Unnayan Kendra (PROSHIKA)

Dr. Siddiqui analyzed the potential for fishery development in Bangladesh by dealing with licensing and leasing system. According to Dr. Siddiqui, both licensing and leasing were tried in the past with no positive outcome. Whatever merit and demerit each system may have, participation of beneficiaries is needed in articulating and formulating any policy for fisheries development and management.

PROSHIKA (an NGO) is involved in one fishery in Netrokona. Pressures from the local power group were enormous when the fishermen began to organize. So, the initial task of organizing the fishermen is difficult. The so-called Fishermen Cooperatives are "big fish". They are to be eliminated before the benefits can be distributed to the actual fishermen. NGO's can play a vital role in organizing the fishermen, as had been done in the case of landless people.

Fishing Activity, Factor Ownership and Distribution of Benefits in Bangladesh

M. Sekandar Khan
Department of Economics
Chittagong University, Chittagong
Bangladesh

Khan, M.S. 1989. Fishing activity factor ownership and distribution of benefits in Bangladesh, p. 95-101. *In* M. Agüero, S. Huq, A.K.A. Rahman and M. Ahmed (eds.) Inland fisheries management in Bangladesh. Department of Fisheries, Dhaka, Bangladesh; Bangladesh Centre for Advanced Studies, Dhaka, Bangladesh; and International Center for Living Aquatic Resources Management, Manila, Philippines. 149 p.

Abstract

Fisheries in Bangladesh are a common property resource. As such, they are subject to possible over-exploitation if unproperly managed. There is a controversy regarding the effect of the present system of leasing various water bodies, whether it renders fishery a free-access resource or not. Fishing vessels and gear are owned by the fishing team leader who organizes the business with a team of family and hired labourers. The labourers are generally related to the leader through kinship ties. Socioeconomic factors play an important role in labour hiring relations. Stratification of fishermen on the basis of "use of outside labour to "family labour" appears to be suitable to analyze the income sharing among various classes. Of the different inputs of fishing, marginal product of the net is negative and that of labour falls short of its earnings. Boat yields a high marginal product. Sharing of output among boat, net, and labourers is not uniform in all sites. Input share values do not exhaust revenue income. The residual represents an amount by which the boat and net owners appropriate a part of rental for the stock. Investment in fishing appears to be profitable if the rate of return is compared to the institutional rate of interest.

Introduction

In Bangladesh, fisheries remained an exclusive domain of biological sciences until very recently when it dawned on policy makers that the subject should be approached from other angles if this sector was to play its role as a contributor to development. Fisheries came to be recognized as an important sector in the 1970s. It was assigned a role to play in five-year plans which, in earlier times, confined attention only to making provisions for scientific research on breeding and propagating the breeds and designing better gears and crafts. But the falling production in this sector created awareness of the fact that factors responsible for stagnation, or even decline of the sector were not only rooted in the unavailability of exotic species or modern gears and motorized boats. It also required appropriate measures for bringing into use the hitherto unused water bodies such as ponds and settling the problems hindering economic utilization of the common property resources such as the riverine waters and inland depressions as these issues relate to disciplines such as economics and sociology. The involvement of social scientists in fishery has been only recent and its contribution to fisheries development therefore, remains meagre until now. Information about property rights in fishery and system of sharing output is scanty. The relevant parties in fishery activity still need to be fully identified and their interrelationships qualified and analyzed for a better understanding of the problems of fishery development.

Introduction of new and improved gears and vessels in the recent years has caused over-exploitation of some capture fishery resources of the country. The benefits generated by the new technology are feared to be unequal to different social groups. The benefits are to be analyzed from a social point of view and so also the costs. The sharing system in the production process is to be understood in reference to asset ownership and labour contribution. These are important to make any deliberate management effort successful in ensuring economic utilization of the resources and also generating maximum benefits for the nation. The present paper is devoted to an understanding of the present property system in inland fishing waters, property ownership structure of fishing vessels, gear and equipment and analyzing the benefits and costs of fishing activities and distribution of income.

This paper, although not an original piece of research, draws extensively on a few research reports well documented in the past and referred to in the bibliography.

Property System

The abolition of the feudal system of the past resulted in the establishment of direct control of the government over the natural water bodies. These water bodies are leased through auction in segments generally for a period of one to three years (see A. Rahman this vol.). Although in principle the fisherman cooperatives are entitled to participate in the auction, it is found that through manipulations and malpractices, fishing rights in many cases are passed on to nonfisherman capitalists who work through dummy cooperatives which are their creation and are financed by them (Huq and Huq 1985). The annual and short term character of the lease period through the auction system of confering tenurial right has the disadvantage of giving the lessees a sense of insecurity which creates a tendency among them to maximize their present catch without regard to its possible destructive effects on the fish stock and future productivity. There are also some *haors* which are privately owned. Their

private owners enjoy fishing rights almost permanently. They are usually the better-off members in the society and generally they engage in money-lending and trading of fishes at the same time.

In the riverine sector, the Ministry of Lands arranges to grant the exclusive right of fishing by auction to the highest bidder for leases that last for one year. The private lessee who is usually a fish merchant or money lender, negotiates with fishermen the right to fish on payment of a cash rent or a share of the catch (sub-lease). Sometimes, the fishermen's cooperatives receive such leases at a negotiated rent based on average rental over the preceding three years. On the basis of a survey conducted in 1980-81, Ullah (1985) identified two other types of property rights over the different segments of the River Jamuna besides the two types already mentioned. They are: (a) *Debottar* properties; and (b) privately controlled water bodies. The *debottar* properties (reserved to support worship of Hindu deities) are rent-free tenures. On the other hand, privately owned water segments are *maurasi jalkars* held in perpetuity at a fixed rent and the ownership is passed on to the heirs of the original holders.

From an analysis of the property system in River Jamuna fisheries Ullah (1985) observes that "various types of barriers to entry into the lease market eliminate the insecurity generated by the legal requirement for the renewal of leases" from time to time. He points out in this connection that the policing cost to ensure that no fisherman can evade payment varies between the (two) intending bidders. Thus, a low-policing cost enables a set of lessees to perpetuate their leasing rights. He also points out that the government bureaucracy also feels assured in renewing lease to them as they are "the type of people who would be least likely to default in paying government dues". It is, therefore, natural that lease market is not as competitive as it may appear from leasing arrangements. The differential nature of costs (of policing and manipulating the authorities) of different sets of people has resulted in a stable group of lessees. The above conclusion of Ullah (1985) is in sharp contrast to the idea commonly held about the nature of lease market and the effect on productivity as a result of the present system of leasing on an annual periodic basis. Khaled (1985) observed that because there is no guarantee that a lessee will get "lease of the same fishery in successive years, he behaves as if there is no future ". He concludes that the riverine fisheries of Bangladesh are characterized by free-access. The lease holder is not the operator in fishing. He collects toll from the fisherman on the basis of type of net or boat used in fishing. There is no tendency on the part of the lessee to impose any restriction on the level of effort or on the size of fish caught. He aims at maximizing the toll revenue, which are a fixed cost to the fisherman.

The position taken by Khaled is based on a sound theoretical support. Here he points out the perennially poor living conditions of the fisherman. The lessee has no interest in seeing that the stock is not over-exploited. There is no guarantee that he will get lease next year also. His only objective is to earn maximum toll revenue in the present year. On the contrary, Ullah (1985) citing the "various types of barriers to entry into the lease market" eliminating "the insecurity generated by the legal requirement for the renewal of leases from time to time" emphatically argues from his assessment of the situation actually concluding that the River Jamuna is not an open-access fishery. He also found that value of average product is

greater than value of marginal product (VMP), which is again greater than wage. One can, however, still point out that growing overcrowding may one day render the private lessee's hold on the situation loose. He will have to allow larger entry and higher fishing effort in order to continue in his position of power. In that case a different type of property right system will have to evolve taking all the parties involved in the business into its fold for proper maintenance of the biomass and for ensuring a fair living to the fishermen.

Property Structure of Fishing Vessels, Gear and Equipment

In the riverine fisheries, the production unit is a fishing team that is usually organized by the owner of boats and nets. The vessel is the sailboat and nylon nets which are used in recent times in place of cotton nets. Two types of nets, i.e., drift nets and seine nets are generally used for catching hilsa, the single most important species in the rivers. The nets vary primarily in length and number of men and boats required to operate them. The other inputs are floats and weights for keeping the nets upright, sail of boats, lanterns and flash lights etc. These are found to be used proportionally to the size of net or size of boat (Khaled 1985).

The fishing vessels and gear are owned by the organizer who is the leader of the fishing team. He also hires labour and arrange funds to meet variable costs of the fishing expedition. The labourers do not posses fishing boats but some of them are found to posses nets.

In *haor* fisheries, the owner of boats and nets are also the entrepreneurs. However, boats are not needed in all segments of *haor* fisheries or throughout the year. Thus, nets are the more important equipment for fishing. The organizer here is a much smaller operator and, therefore, access to fishing is much easier. The operator is, in most cases, the household head who works with members of his family as a fishing team.

Labour Characteristics

The labourers in the fishing team belong to the neighbourhood of the team leader's residence. They are sometimes related to the leaders through kinship ties. This kinship is both blood kinship and fictive kinship. Factional loyalty to the leader is found to be important for a labourer to be hired by a particular team leader.

Fishing in the riverine waters is distributed mainly into two seasons - the dry fishing season extending from August to February, and the wet fishing season extending from February to August. These seasons are alternatively distributed as April to September and October to March by some researchers. Usually the teamleader hires a labourer for one season. The labourer is found to change teams from one season to another. This can be attributed to his tendency to even up the "luck" factors in fishing.

Originally, Hindus dominated the inland capture fishery as fishermen. The Hindu fisherman is a low caste (*sudra*) in the social strata. He sticks to his profession because it is a "sin" for him to move into a higher occupation reserved for the upper castes. Recently Muslims have entered into this profession. This is so, in spite of the fact that becoming a fisherman is a taboo for the Muslims. Their entry was facilitated by migration of Hindus to India after partition of India in 1947. In addition, erosion of river banks and continuous marginalization forced Muslims hitherto dependent on land to become fishermen.

Labour hiring relations that exist in traditional fishing are determined by an interaction of sociopolitical and economic power. It is not appropriate to use the term market to signify the labour hiring relations in fishing (Ullah 1985). Labourers are hired, as has been pointed out, on considerations which are not economic only. In the survey of riverine fisheries in the River Jamuna the largest team found to operate was composed of 40 members. They are generally hired for one full fishing season, and they receive a traditionally determined share of the catch. The team leader also works as a labourer and receives shares for his boat and net as well as for participation in the operation. The shares, as found in the River Jamuna, are 1/2 for boat, 1/4 for net and 1/4 for labour. This differs with what was obtained in other areas, i.e., in Meghna at Chandpur, where half of the revenue (after deductions for variable factor cost other than that for labourers) goes to the owner of boats and nets and the remainder is divided into equal parts in which the team manager gets two parts and others receive one part apiece.

Income Generation and its Distribution Among Different Economic and Social Groups

The fishing team leaders may be divided into different groups on the basis of their asset ownership, ratio of income received from fishing and non-fishing occupation and many other economic and social traits. Such division of the operators is relevant in our case for an understanding of the inner dynamics of the system. This is required to design policy measures to act upon the course of that dynamic development. Stratification of peasants in Bangladesh has been attempted by different scholars on the basis of different criteria. It is not within the scope of this paper to review these. A summary of them has been attempted by Rab (1983). One of the criteria is the E-criterion developed by Patnaik (1976) which is based on the degree of "use of outside labour relative to the use of family labour". This criterion is significant as an attempt to understand the structure and dynamic of capitalism within peasant agriculture. Ullah uses this criterion to stratify the fishing team leaders. He classified them into three economic classes:

Protocapitalist class
Upper artisanal class
Lower artisanal class

From a regression analysis with the data pertaining to Jamuna River fisheries, the contribution of boat, net and labour was found positive. It is interesting to note that at a higher "labour exploitation" ratio stratum, the catch of fish goes down significantly.

Next, based in the Marxist concept of the rate of profit which also corresponds to the team leaders' own notion of profit (i.e., net revenue divided by the cost of production) the three types of work organization did not show significant difference in the rates of profit. This was the result of similarity among the teams in respect of boat capacity to labour employment ratio.

The more interesting phase unveils itself when one brings into focus the other role of the lessee as the chief or monopoly buyer of the fisherman's catch of fish. The protocapitalist class fishing-team leaders generally fish in distant *jalmahals* remote from the fish distribution points. Their fishing rights and the disposal of catch

become interlocked. This situation changes in the case of upper and lower artisanal classes. They, especially the latter group, work with small capital and therefore, fish in segments adjacent to their own villages and catch a small amount of fish per trip.

The small artisanal fishermen earn a high rate of profit, higher than the protocapitalist class of fishermen who face a relatively inelastic demand for their product. The higher labour exploitation stratum is also constrained to sell instantaneously more and more of their catch.

Rent payment and profit earning are inversely related, the association getting weaker as one moves from higher to lower labour exploitation ratio stratum. All the three classes have high positive correlation between profit earned and the extent to which wage is short of value of the marginal product of labour.

The above analysis of the distribution of income among various entrepreneur classes shows that the rich class receives the same profit rate as the others. The difference is in the absolute volume of profit. Since the richer class operates on a larger scale they receive a larger absolute amount as profit. It is seen that in the marketing of product the small artisanal fisherman has a locational advantage in that he is situated near the place of consumption and his catch finds an easy sale because of the small quantities involved. The larger fisherman depends on the big fish merchants to carry his catch from the place of harvest. The situation turns further adverse for him when the lessee himself is the fish merchant he has to bargain with.

Benefits Generated by Various Gear, Species and Areas

Production technology differs from site to site. As has been pointed out before, the boats and nets differ in length, weight and mesh sizes. Again different gears are used for different species of fish. Khaled (1985), working with data of rainy season fishing in Meghna at Chandpur, estimated the different (3) input elasticities of output for boat, net and labour in the catch of hilsa. The results indicate that "the net is characterized by a negative marginal product". It appears that using fewer or smaller nets but more labour and boat tonnage is conducive to larger "catch". He also found complementary relationship between labour and boat. However, labour and net, and boat and net were found to be substitutes.

Again, the earnings of labour and net were found to exceed the value of their marginal product whereas the imputed cost of boat fell short of the value of its marginal product. He further points to an important aspect of the results of his estimate. It was found that the input share value of labour, boat and net do not exhaust the revenue incomes and the residual accrues to the owner of boat and net. This residual, he argues, actually belongs to the society as rental for the stock. Thus, it reveals that there is scope for further increasing the rental or licence fees.

Fishing sites differ in stock and, therefore, in amount of fish caught. Even the fish caught in different areas taste differently depending on the quality of the water. Difference between Meghna River fishery at Chandpur and Jamuna River fishery at Goalunda have been found significant

(Khaled 1985). There is also difference in the nature of the collection by the lessee in the two sites. These differences have their effect on the effort applied by the fishermen and therefore, on the extent of exploitation of the fish stock.

Share System in the Production Process

As has been pointed out, the system of output sharing varies from site to site. The fishermen pay the toll to the lessee and deduct all the costs for variable inputs like, fuel, flash lights, bamboo poles, etc. and for small repairs of nets and food during a fishing expedition. As regards the toll paid in term of shares of the catch there is again no uniform practice. The share surrendered to the lessee varies from one-half to one third of the gross amount of catch depending on:

(a) the amount of biomass, (richness of stock);

(b) degree of the team leader's socioeconomic influence over the community (representing his ability to help the lessee in policing);

(c) level of effort exerted by the fishing team; and

(d) nature of organization holding the lease.

Lease holding fishermen's cooperatives in which genuine fishermen are involved in the management are found to charge a fixed rental from the fishing teams for a particular season. The remainder of the catch is distributed among boat and net owners and the labourers according to a predetermined ratio.

Shares assigned to boats and nets vary according to their sizes. Owners of these assets bear the cost of major repair. Boats and nets receive one half of the catch (after all deductions) and another half is distributed among all participants of the fishing team. The boat and net owners, i.e., the team leaders often take part in fishing and therefore, receive a share as participating labourer. There are other systems of sharing of catch. The rate of return in fishing has been found to be very high in the works cited in this paper.

Comparing the above rates with the rates at which funds for fishing can be contacted from institutional sources it may be observed that fishing is still a highly profitable line of investment. But compared to non-institutional rates it may be observed that over-investment has occurred in fishing. This has occurred because, as has been pointed out before, the return to investment engulfs an amount that actually is rental for fish stock.

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Fishing Activity and Distribution of Benefits in Bangladesh

Sultan H. Rahman
Bangladesh Centre for Advanced Studies
Dhanmondi, Dhaka
Bangladesh

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Abstract

In this study, an analysis is made of the economics of fishing activities in four selected river sites of Bangladesh. An analytical framework is developed which allows an understanding of economic management issues and provides the basis for computation of costs and returns of various types of fishing gear used by fishing units in these sites. An estimate of the catch per unit effort (CPUE) and catch rate is also provided for all four fishery sites. The economic analysis reveals the existence of significant economic rents and pure profits in all four sites. The profitability of fishing is higher in the two sites under the management of the Department of Fisheries (DOF) compared to the other two fisheries which are under the traditional management. The study, however, does not provide a causal explanation of these differences. It is also found from implicit wage rate computations that fishing is relatively more remunerative than alternative income generating opportunities existing in and around the fishery site.

Introduction

This paper is an attempt to analyze the costs and returns from fishing activity in some of the inland open-water fisheries of Bangladesh currently monitored by the Project "Experiments in New Approaches to the Improved Management of Inland Open-water Fisheries of Bangladesh" (see Agüero this vol. and A. Rahman this vol.). It also analyzes the distribution of the gains from different types of fishing activities. Only fishing activities in one inland open-water environment, i.e., flowing rivers are considered in the paper.

The nature of inland open-water fisheries

The open-water inland fisheries of Bangladesh are natural systems. There is no conscious human intervention in the reproduction cycle and growth of the various fish species that inhabit these fisheries. The entire biological cycle from reproduction to maturity, and migration is dependent on nature i.e., the environment. Growth and maturity of fish is, therefore, a natural activity as distinct from a fish culture activity. This natural cycle is of course disturbed by the tertiary effects of fish harvesting and other indiscriminate practices by people. The rivers and floodplains systems of Bangladesh become an interconnected mass of water body for over 5 months of the year centering around the monsoon (June-July) when water levels are highest.

The major inland open-water fishery environments in Bangladesh are rivers, *beels* (natural depressions), *baors* (ox-bow lakes) and flood plains. More than 200 species of finfish and a variety of species of prawns inhabit the open inland water areas (see Agüero this vol.). The differences in species distribution and physical features of the water environments cause the fish capture technologies to differ across environments. Almost all the fin fish and prawn are popular food in the Bangladeshi diet. The available fish species can be broadly grouped into the following five categories: hilsa, carp, catfish, prawns and others.[a] Each of these broad groups and within these, the different species have their own biological cycles and migratory behaviour. Their seasons of relative abundance, therefore, vary.

The long tradition of fishing in Bangladesh is another important determinant of fishing technology. Fishing boats used to operate the gear and transport fish also vary greatly in size, and are predominantly non-mechanized country boats. Fishing activities in Bangladesh are therefore artisanal in nature.

The traditional fishermen of Bangladesh are low-caste Hindus distinguished easily by their titles. They are predominantly landless or land-poor people with low standards of living. Fishing input requirements (e.g., boat, net, etc.) are typically not very large. Fishermen generally own the boat and net either individually or as a group; labor wages are paid through catch-sharing basis. The distribution of catch, however, varies depending on the nature of the fishing effort and the aquatic environment.

Fish marketing in Bangladesh is characterized by a long and intricate chain of intermediaries. The intermediaries perform useful functions such as collection of fish

a See List of Important Fish and Prawns, Appendix 3, p. 142.

from the harvesting grounds, transportation to primary and secondary markets, storage, processing, etc. Market prices of fish at each level, i.e., primary, wholesale and retail are mainly determined by interaction of demand and supply. The market price of fish at each level reflects a market-determined (equilibrium) exchange rate between the buyer's willingness to pay and the supplier's willingness to give up ownership of the fish. The sales revenues received by the fishermen after exchange in the market yields his income after adjustment for costs incurred by him (inputs, etc.) on account of fish harvesting.

The preceding discussion shows the complex nature of inland open-water fishery systems of Bangladesh. The interactions of the elements of various disciplines with different types of environments poses a serious challenge to any investigator venturing to study and analyze these systems. A further problem is posed by the fact that the inland open-water fishery systems have not been widely studied in Bangladesh, particularly within an inter-disciplinary framework. In spite of the complexity of the system, efforts must be made to develop models or analyze systems interrelationships so that policy issues related to these fishery systems may be analyzed and studied.

Material and Methods

The analytical framework

It may be conveniently assumed that fish harvesting takes place in response to a given demand for the fish. Consumer's derive "utility" from the consumption of fish, and their preference is reflected in demand functions for fish. The fisherman is a commercially-oriented agent, i.e., he catches fish mainly in order to sell and not for his personal consumption. Thus, in response to a given market demand for fish, the fisherman combines his inputs, viz. labour, boat and net in order to catch fish. The input combination may be viewed as "fishing effort" and the fish catch as output.

As an economic activity, fishing will be worthwhile if it yields revenues from sales that at least are enough to cover all costs of production, i.e., fixed and variable costs. Thus, all input costs whether purchased, borrowed or provided from own (or family) sources incurred in a given fishing effort must be considered and compared with revenues obtained from the sale of catch generated by that same effort.

For analytical convenience, it may be assumed that the fisherman optimizes his fishing activity in the sense of economic rationality and that the resource is not rent free. In other words, he expands fishing activity up to the level where the additional cost of his effort equals the additional revenue earned from the catch obtained by exerting the additional effort. In other words, fishing effort would, therefore be expanded up to the level at which the marginal profit (marginal revenue minus marginal cost) would drop to zero. Under competitive market conditions such an optimization of fishing effort would result not only in the maximization of profits of the individual fishermen, but also in the maximization of returns to society as a whole.

A fundamental characteristic of the open-access fish resources is the "conflict" of interest between the fishermen and society. The "conflict" occurs at two levels: (1) rent that belongs to society but is not captured and (2) biological destruction of the resources.

However, the fishermen's decision problem under open-access conditions is quite different. He maximizes short-run profits from his fishing effort. To him

the fish stock is a "free" resource to which he has open access constrained only by his physical and financial condition. Thus, while the cost of the fish resource to the fishermen is zero, there is indeed a positive (user) cost of the resource to society. It is due to this "free-of-cost" nature of the fish resource that fishing effort may be expanded to levels which are socially undesirable.

In order to analyze the profitability of fishing, it is necessary to develop an economic model of the fishing system. Figure 1 provides a simple model to investigate issues of economic management and profitability of fishing. The components of the model are described below:

Sustainable yield function

The biological relationship between yield (catch) and effort is more complex than the economist's or technologist's view of a production function (see Ricker 1975 for details on the relationship).

The behaviour of the yield function is characterized by the law of diminishing marginal returns. Thus as effort increases sustainable yield first increases, reaches a maximum and then declines falling to zero at a very high level of effort. The sustainable yield function can conveniently be transformed into a total revenue (value) function by applying market prices to it, which leads to a simple economic

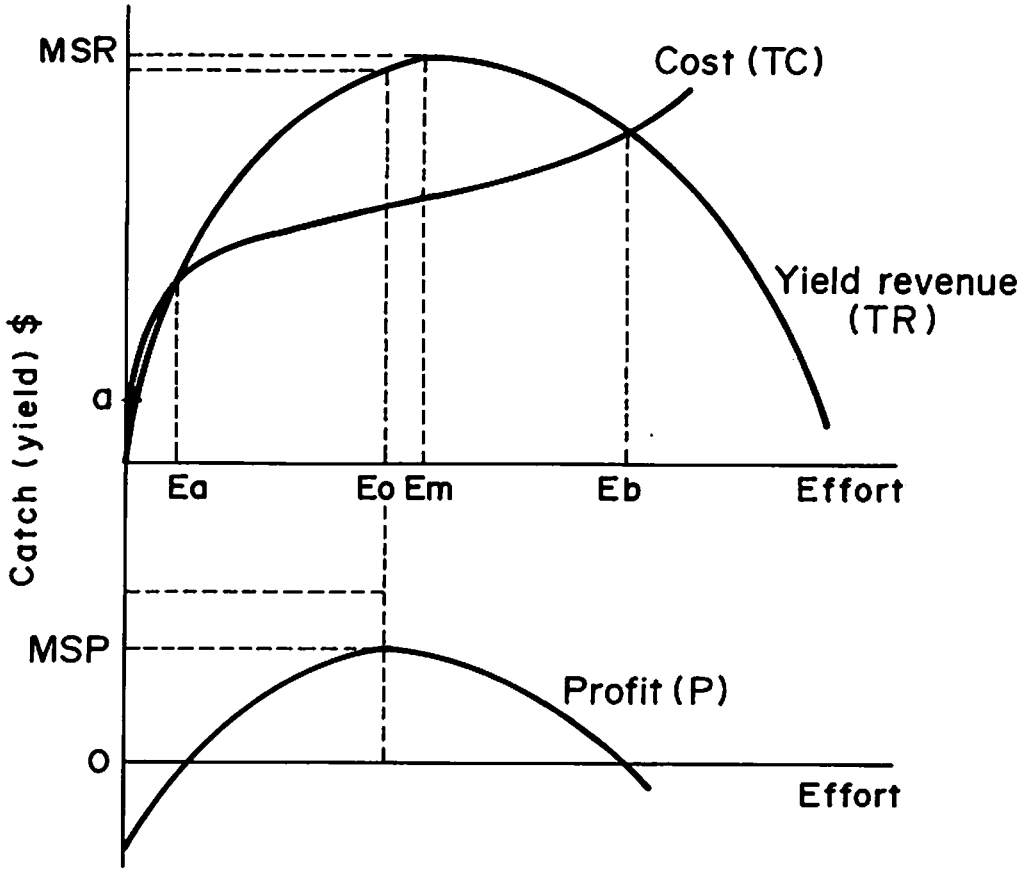

Fig. 1. Traditional bioeconomic model of fisheries.

model. The sustainable yield (value) function, therefore, combines elements of biology, technology and economics, and provides a unique interdisciplinary theoretical apparatus for fishery policy research.

Cost function

The total cost function may be viewed as a typical neoclassical cost function with one important distinction, i.e., the relationship is specified between cost and effort instead of output. The relationship between cost and output is established indirectly through the sustainable yield function. The cost function is specified over the entire range of effort in the production function and hence, shows increasing, constant and diminishing marginal returns which governs the behaviour of the function and hence its shape (Fig. 1). As marginal returns begin to diminish beyond a certain level of effort variable costs rise.

The net-return functions

The net-return (revenue minus costs) function is in effect a profit function of the form:

$$\pi(E) = R(E) - C(E)$$
$$\text{where, } R = P.Q(E)$$

The height of the sustainable yield function (Y), gives the maximum sustainable yield (MSY) corresponding to effort level E_m. Transformed into values the yield function becomes a total revenue function showing the level of revenue associated with each level of effort. In the range of effort E_a - E_b, profits, i.e. difference between revenue and total cost (TC) are positive (Fig. 1). The intercept of the total cost (TC) function on the Y-axis is a measure of the total fixed costs which are invariant with respect to the level of effort within a given fishing season at least. Though revenues are maximized at effort level E_m, profits are not. Profits are maximized at E_o, where the difference between the two functions, i.e., Y and TC is maximum, as seen in the lower section of Fig. 1, represented by MSP.

It is economically irrational to expand effort beyond E_e, since, the additional cost of such an expansion could exceed the additional revenues obtained. A non-optimizing fisherman could operate in the range of effort E_m - E_b since profits would still be positive, however, this would impose a cost on society.

With abundant fish resources, revenues are expected to exceed cost at low levels of effort. High levels of revenue would attract increased effort, reducing incremental profits beyond Ee. Profits eventually drop to zero at E_b. The profit function therefore, yields positive profits in the range E_a - E_b, reaching a maximum at E in Figure 1.

In an open access fishery without barriers to entry, rents drop to zero at E_b. Effort and the fish stock both stabilize at E_b which is also known as the open access bioeconomic equilibrium. Even for the non-optimizing fishermen (or industry) there is no incentive to expand effort beyond E_b. In the long run, fishermen operating in the range of effort beyond E_b will be forced to withdraw from the fishery due to losses incurred. It is important to note that in general, with a stable physical environment and economic condition, an open access fishery without barriers to entry would be expected to converge towards a bioeconomic equilibrium characterized by zero economic rent.

At the bioeconomic equilibrium E_b, fishermen earn no pure profit after covering the opportunity costs of all inputs. Thus, society earns no rent from the fish resource. Given that fish resources are scarce and need to be conserved, society should charge fishermen a rental (user cost) for the

use of the resource. The rental added to existing input costs (capital, and labour) would increase the total cost per effort, thus forcing fishermen to reduce effort resulting in conservation of the resource and maintaining it at a level which maximizes net economic benefits to society.

Computations of costs and returns assume great importance within the theoritical framework provided above. Major indicator variables such as catch per unit effort (CPUE), cost per unit of catch, return per unit of catch, the total effort, economic rents, etc. over time in each fishery and across fisheries at a given point of time may also be computed. Persistent and widespread evidence of zero or negative profits in a fishery would indicate that the fishery is fully exploited or over-exploited respectively. With zero profits, i.e., full exploitation, the fishery would reach the long-run steady-state or bioeconomic equilibrium. An appropriate set of policy recommendations would then have to be made to improve management of the fishery.

The methodology

The sample

Sample frames for all the 4 flowing river sites were available to us. The frames consist of an enumeration of non-*bhasan* fishing units with names of members. These members or fishermen live in fishing villages around the water body. Random samples were drawn from the frame in each site (Table 1). The fishery units thus selected, were interviewed with a structured questionnaire and their responses were recorded. No stratification of fishing units according to gear used was deemed necessary prior to drawing the random sample.

Data from 199 fishing units spread across the four river sites have been used to make the computations presented in this paper. The distribution of respondents by type of gear in each fishery site is shown in Table 2. The sample survey was conducted in late March and early April 1988. Respondents provided catch estimates over a previous 3 month period covering the Bangla months of Poush Magh, Falgun (mid-December 1987 to mid-March 1988).

Variable costs

Variable (operating) costs of fishing consist of the following: food, fuel, minor repair and maintenance and other miscellaneous expenses. It was explained in Anon (1988) that the fishermen covered in the samples in all sites undertake fishing activity on a daily basis being based in their homes to which they return at the end of each fishing day. Thus, the expenses on major meals, e.g., lunch

Table 1. Distribution of sample by fishing ground (location).

Fishing ground	No. of respondents (fishing units)	Sample frame (total fishing units)	Proportion sampled (%)
Nayabhangni	33	107	31
Meghna	90	1,592	6
Narisha - Padma	47	237	20
Padma - Jamuna	29	191	15
Total	199	2,127	9

Table 2. Enumeration of gears in different fishery sites.[a]

Type of gear (Location)	No. of respondents
(Meghna-Nayabhangni)	
Boat-seine net *(Cona ber jal)*	13
Seine net *(Dhara jal)*	10
Gill net *(Chandi jal)*	6
Gill net *(Langta jal)*	3
Gill net *(Pait jal)*	1
(Meghna)	
Gill net *(Chandi jal)*	34
Gill net *(Langta jal)*	30
Gill net *(Dora jal)*	26
(Narisha-Padma)	
Gill net *(Dora jal)*	15
Dipnet *(Vhel jal)*	12
Small-mesh seine *(Ghano ber jal)*	10
Gill net *(Paich jal)*	3
Gill net *(Chandi jal)*	2
Clapnet *(Shangla jal)*	2
Seine net *(Cona ber jal)*	1
Cast net *(Zhaki jal)*	1
Seine net *(Moi jal)*	1
(Padma-Jamuna-Balbonth)	
Gill net *(Dora jal)*	19
Gill net *(Chandi jal)*	3
Small-mesh seine *(Ghano ber jal)*	3
Dipnet *(Vhel jal)*	2
Seine net *(Moi jal)*	1
Dragnet *(Shatting jal)*	1

a) BCAS ENIMOF Report.

or dinners do not comprise a part of *the operating* expenses of fishing units. Food costs considered in the study are merely expenditures on snacks and smoking materials, etc.

Fuel costs consist of expenses on kerosene for lamps and batteries for torch light. These expenses are small as well, since the overwhelming proportion of the fishermen undertake fishing during the day. However, pre-dawn and post dusk hours are often involved necessitating the use of lamps and torchlights. Fuel costs are estimated at roughly one Taka (Tk) per fishing unit per day. Minor repair and maintenance costs are a continuous activities. Virtually every week throughout the fishing season, fishermen must mend their nets or replace some accessories e.g. weights, etc. This cost is proportional to the size of the gear which is in turn reflected in its value. The cost of minor repair and maintenance works out at approximately 1% of the capital cost of the gear. Other variable costs are included to cover miscellaneous costs related to fishing and is approximated at 3% of the sum of food, fuel and minor repair and maintenance costs. All variable costs are estimated for a one- month (30 day) fishing period.

Fixed costs

Fishing units must pay a fee to obtain or renew their fishing rights every season. The mode of payment, however, varies depending on the type of environment. In the riverine fisheries the payment takes the form of a one-time license fee (for the entire fishing season) in case of Department of Fisheries (DOF) managed fisheries and a one-time toll payment in case of Land Administration and Land Revenue (LALR) managed fisheries. These payments for fishing rights are, therefore, treated as fixed costs.

Major repair and maintenance costs include replacement of major portions of the net lost through accidents, wear and tear, etc. other fixed costs are incurred for replacement of bamboos, oars, parts of the sail, containers, etc. i.e., gear and boat accessories. Major repair and maintenance expenses are normally incurred once or twice in a fishing season.

Depreciation is a non-cash fixed cost. The capital cost of all types of the gear, boat and other fixed costs, their salvage values and expected life in all 12 sites were obtained from the sample survey. Depreciation costs of gear boat and other accessories were obtained using a linear method. The costs of depreciation, however, accrue to the owner of the fixed capital, i.e. gear and boat and their durable accessories.

All variable and fixed costs which are one time investments were converted to monthly terms (30-day basis) to facilitate computations of income and profitability of fishing units on a per month basis. The symptoms of underemployment in relatively overpopulated countries like Bangladesh are well known. The problem is serious in rural areas and appears to be even more acute for the fishing community. Around most of the fishery sites under consideration alternative employment is difficult to obtain, since these areas are less suited for agricultural activities and are far removed from major rural centres where alternative economic opportunities are greater. The rise and submersion of charlands and rapid bank erosion are the dominant characteristics of the ecology of the river fisheries, in particular. Further, fishermen may undertake fishing activity as an inherited practice. These factors make it difficult to compute the opportunity cost of fisherman's labour. Conventionally, a 0.75 conversion factor is used to convert agricultural market wage rates to shadow wage rates in Bangladesh. Given the realities of the alternative employment situation within which fishermen operate, the shadow wage conversion factor was further adjusted downwards to 0.50 to compute the opportunity cost of labour. The market wage rates for skilled and unskilled labour were obtained through the field survey.

Determining the opportunity cost of capital is also difficult. Both investment-orientation and opportunities are lacking in Bangladesh. The best possible alternative investment option for gear and boat-owning fishermen appears to be bank savings accounts which carry a 10.5% per annum rate of interest in rural areas. Thus, a 10.5% per annum rate has been used in computing the opportunity cost of capital.

Revenues and income

Revenues or returns from fishing are computed as the product of price and quality of fish catch. Net income and profit of the fishing units are the same since no wage payments are involved in the type of capture fishing activity under consideration in this study. The fishing activity will be ensured in the long run only if depreciation is taken into account, i.e, an investible surplus is generated for replacement of the capital equipment at the end of its expected life time. However, this is a charge accruing to the owner of capital, who is entitled to a 50% share of the gross income. Thus, computation of the capital owner's net income (gross income-depreciation is also made) to his long-term sustainability as a fishing entrepreneur, and hence, of fishing units. Since, there are no wage payments involved from this net income, this is also the capital owner's net profit. His pure profit is computed as the difference between net profit and the opportunity cost of capital. Again, the rate of return on his capital is computed as the ratio of pure profit (measured on a monthly basis) to total investment. As for the fishermen crew of the unit who only provide labour, their rate of return is computed as the ratio of their share of gross income of the unit to the opportunity cost of their labour.

Catch per unit of effort

The catch per unit of effort (CPUE) is a crucial concept in fisheries management. It may be defined as an aggregative ratio of total catch to total fishing effort. If the total catch is known in a given fishery (which is relatively easier both as a concept and to measure) and either effort or CPUE is known, the other can be determined. The regulation of fishing effort provides a major policy instrument for the management of fishery resources. This critical parameter must, therefore, be measured. But, this is where the difficulty begins.

Fishing effort comprises the labour of fishermen and the use of gear (nets) and boats. It is conceptually difficult to aggregate these diverse inputs into a single index. Conversion of these inputs into time e.g., hours of use could be one way out. However, these inputs are also complementary in nature in traditional fishing at any rate. A high number fishermen-days could also reflect use of a larger (or heavier) net and more boats. Thus, any one of these three inputs expressed in units of time (hours) could possibly be a good proxy for fishing effort.

The number of days and hours of fishings and the number of fishermen in each fishing unit were available from the field survey data. The number of man-hours of fishing by each unit was thus computed as a measure of effort. Technical details, e.g., number of sections, length of each section, width and weight, number of hours of operation per haul and number of hauls by gear in all 4 sites are also known from survey data. The product of the number of hauls,hours per haul of each gear and number of days of fishing by each unit provides the total hours of use (net hours) of each gear, which is also another measure of fishing effort. Total catch quantity of each fishing unit in each of the four sites divided by the total fishermen hours (i.e., the first measure of effort stated above) is the CPUE reported in this study. Using net hours as the denominator gives another catch per unit of effort measure which was also computed.

Further complexity was also considered. The number of hours of operation of the same gear is not the same when for instance there is great variation in length,weight or mesh size among gears. Third and fourth catch per unit of effort measures (index) were thus computed by adjusting (dividing) the net hours by length of net and by weight of net. This would be an attempt to standardize net hours. However, these refinements did not significantly alter the ranking of CPUE given by type of gear in each fishery, though it changes the magnitude of CPUE as expected. Thus we have only reported one measure of CPUE. It may also be noted that a much simpler notion such as catch rate (catch quantity divided by the total number of hours of fishing) which may also be considered as a crude CPUE index, gives virtually the same ranking of CPUE by gear in each fishery as the CPUE when fishermen-hours is used as the denominator.

Cost per unit of effort

Profitability can be derived in relation to effort unit, defined as the difference between cost per unit of effort (COPUE) and average revenue per unit of effort (ARE). In computing COPUE and ARE the following definitions were followed:

COPUE	=	CPUE x Cost per catch
ARE	=	CPUE x Price

Results and Discussion

Gains from fishing and their distribution

Table 2 shows an enumeration of fishing gear used in the December 1987 to March 1988 period in each fishery site. Except in Narissa-Padma most gears used were specialized in hilsa catch. Catch data both in terms of value and quantity show a high hilsa concentration in all the flowing river fisheries. Even in Narissa-Padma, where hilsa catch is the lowest, 50% of the catch value is contributed by hilsa, compared to 81%, and 100% hilsa catch in Padma-Jamuna, Meghna and Meghna-Nayabhangni river fisheries, respectively. It is important to note that the hilsa catch as a proportion of total fish catch declines as we move upstream from the lower reaches (closer to the Bay of Bengal) of the Ganges. In quantity (weight) terms the catch composition is 35%, 70%, 100% and 95% in Narisha-Padma, Padma-Jamuna, Meghna and Meghna-Nayabhangni river sites, respectively. The survey data contained information on catch data of fishing units in the preceding 3 months (mid-December 1987 to mid-March 1988) and the actual number of fishing days in the corresponding period.

Thus, there was an entire distribution of the number of days engaged in fishing by different units in each fishery. The catch value was, therefore, standardized to a one-month (30 day) period by first obtaining the actual daily catch rates of the fishing units from the survey data and then extrapolating it to 30 days. All costs were computed and/or converted to a 30-day period as stated above, in order to compute profits, etc. In case of one fishery site, i.e., Meghna-Nayabhangni 6 respondents where found to have undertaken fishing actually for an small number of days (less than 10 days in the 90-day period). These respondents were dropped in the economic analysis.

It can be reasonably assumed that hilsa was the predominant catch and hence, source of earning for fishermen in the flowing river fisheries even in the December-March season, which is actually the off-season for hilsa, in particular and hence for fishing in the flowing river sites in general.

The mean catch value in Meghna-Nayabhangni is Tk 6,004 with a standard deviation of Tk 4,088 (Table 3). These two components of the catch value distribution are Tk 8,615 and Tk 6,078; Tk 10,755 and Tk 12,031; and Tk 10,523 and Tk 4,771, respectively for Meghna, Narisha-Padma and Padma-Jamuna fishery sites. The coefficients of variation, i.e the measure of relative despersion as variability of catch value are 0.68, 0.70, 0.42 and 1.11 in Meghna-Nayabhangni, Meghna, Padma-Jamuna and Narissa-Padma, respectively. This is a measure of variation used in this study and is likely to be lower in the peak-season and hence may be treated as an indicator of seasonal effects in fish catch. The Padma-Jamuna fishery which is under DOF-management (with existing resources, i.e., type II), shows the least relative variation in catch value and hence profits or income. It is most significant to note that the mean catch value is highest for Narissa-Padma (DOF-intensive management i.e., type I) followed by Padma-Jamuna (DOF type-II management), Meghna (LALR management) Meghna-Nayabhangni (NGO management) respectively. Profits, and income of fishing units follow the same sequence.

A test of differences between mean catch earnings showed significant difference between mean catch value of Padma-Jamuna and Meghna-Nayabhangni at the 1% level and between Meghna-Nayabhangni and

Table 3. Economic analysis of fishing activities in the flowing river fisheries (amount in Taka).

Name of fishery		Total var. cost	Catch value	Capital cost	Gross income	Gross profit	Depre-ciation	Fixed Cost	Opt. cost of labour	Opt. cost of capital	Invest-ment
MNR	Mean	563	6,004	655	5,350	5,441	507	599	4,117	186	22,779
	SD	226	4,088	267	3,977	3,977	286	318	1,736	117	13,071
MER	Mean	637	8,615	740	7,875	7,978	583	686	5,593	193	22,369
	SD	364	6,078	399	5,924	5,932	308	345	2,820	80	9,291
PJB	Mean	673	10,523	733	9,790	9,850	420	480	4,821	188	21,481
	SD	370	4,472	395	4,438	4,446	460	484	2,077	190	21,779
NPR	Mean	679	10,755	749	10,006	10,076	475	545	5,553	225	25,659
	SD	440	12,031	475	11,872	11,877	399	436	3,377	177	20,252

Name of fishery		Fixed cost	Net income	Net profit	Resource rent	Pure profit	Return to capital	Return to labour	Daily wage
MNR	Mean	92	4,842	4,842	3,195	3,009	20	70	20
	SD	78	3,933	3,933	3,661	3,678	35	89	13
MER	Mean	108	7,292	7,292	4,495	4,303	21	150	28
	SD	91	5,840	5,840	5,268	5,262	74	100	20
PJB	Mean	60	9,370	9,370	6,959	6,771	64	242	37
	SD	37	4,434	4,434	4,636	4,668	57	138	21
NPR	Mean	70	9,531	9,531	6,754	6,530	36	189	32
	SD	52	4,434	4,434	11,304	11,299	54	173	29

Legend:
a) One month = 30 days
b) Return to labour is in percentage
c) Return to capital is in percentage
d) Though the full opportunity cost of labour is shown, it is adjusted by a 0.5 conversion factor in computing resource rent, etc.
e) MNR = Meghna Naya Bhangni River
f) MER = Meghna River
g) PJB = Padma Jamuna Balbanth River
h) NPR = Narisha-Padma Ujan Jala River
i) SD = Standard Deviation

Narisha-Padma at the 5% level. The mean catch value of Meghna was not significantly different from either Padma-Jamuna or Narisa-Padma at the 5% error probability level. The difference in mean catch values of the two DOF-managed fisheries are not statistically significant.

The following regression covering the entire sample survey of 205 units shows a close and statistically highly significant relationship between catch value and gross profits:

$$\text{Gross Profit} = 9652.75 + 1.086 \underset{(52.43)}{\text{catch value}}$$

$$r^2 = 0.88 \quad n = 205$$

Catch value is significant at the 1% error probability level and explains over 80% of the variation in profits.Cash costs

include total variable (operating) and fixed costs. Gross income is the difference between catch value (or earnings) and cash costs. Gross profit is however, the difference between catch value and operating costs only. It has already been noted that fishing in the sample sites, is undertaken on a daily basis (8-12 hours/day).Thus, food expenses include only minor items and no major meals, and hence are small in magnitude. The operating cost of traditional fishing is, therefore, low in Bangladesh. Accordingly, the difference between gross income and profit is small given that there is no cash wage payment.

To be viable in the long-run, fishing units must consider depreciation or capital consumption. Fixed cost in Table 3 includes depreciation. The difference between catch value and all fixed costs including depreciation gives net profit. A test of difference between net profits showed significant difference in the mean values of Padma-Jamuna and Meghna-Nayabhangni.

In economic analysis, self-labour must be valued at its shadow price, though this is taken to be zero in financial analysis (since no cash wage payment is made). Wage rates for skilled and unskilled non-fishermen labour around the 12 sample sites were obtained from the field survey. As explained above a shadow price conversion factor of 0.50 has been used to compute the opportunity cost of 30-days of labour 0.50 has been used to compute the opportunity cost of 30 days of labour time of the 379 sample fishing units. Net profit minus the opportunity cost of labour yields resource rents. Since capital investments have competing claims, economic analysis must consider the next best alternative opportunity forgone by investing in the fishing activity, in making profitability calculations. Pure profits of the fishing units are thus, obtained after deduction of the opportunity of cost of capital from the resource rents. Similar to an earlier report (BCAS 1987) it must, however, be noted that the computations of pure profitability are quite sensitive to the shadow price conversion factor used in computing the opportunity cost of labour, since this cost is large in magnitude.

The magnitude of pure profit has strong policy implications. Zero or negative pure profits would reflect resource exhaustion in a given fishery, i.e., that current catch effort levels are beyond or around the bioeconomic equilibrium levels. This would of course have to be observed repeatedly over time in a given fishery. The results of the present survey do not in any way point to low profits in the flowing rivers even in the "off-season." To draw conclusions about the riverine fisheries regarding their resource position, repeated surveys have to be conducted. In terms of pure profit Padma-Jamuna is the highest followed by Narissa-Padma, Meghna and Meghna-Nayabhangni, respectively. A test of differences between mean pure profits results in the same conclusions as in the case of net profits. Thus, while mean pure profits in the DOF-managed sites are essentially the same, they are significantly different at the 5% level from Meghna-Nayabhangni in both cases. In case of Meghna, the statistical difference is significant only in comparison with Padma-Jamuna and not with Narissa-Padma. Thus, it may be concluded that pure profits are significantly higher in both DOF managed fisheries compared to Meghna-Nayabhangni.

Monthly magnitude of pure profit appears to be substantial even in the "off-season" in all flowing river sites, though it is relatively much smaller in Meghna-Nayabhangni. From the point of view of economic rationality and optimal resource planning, these excess resource

premia should be taxed away. This may be done most effectively by increasing the license fees for gears in the two DOF-managed sites, where these premia are significantly higher.

Return to capital is computed as the capital (net and boat) owner's share of total catch value (obtained by the fishing unit) relative to the total investment in net and boat of the fishing unit. The monthly rates of return to capital investment are very high as may be seen in Table 3. The investment payback period is approximately 6 months, 4 months, 2.5 months and 1.5 months for Meghna-Nayabhangni, Meghna, Narissa-Padma and Padma-Jamuna, respectively. These are extremely low pay-back periods reflecting very low capital costs of traditional fishing in Bangladesh. The return to labour is measured as the ratio of the share of gross income received by the fishermen as labourers as distinct from owners of net and boat to the opportunity cost of labour, expressed in percentage terms. The measure therefore, shows the excess of the return to fishermen labour over the wage income they could potentially earn from working in non-fishing activities (e.g., agriculture) around their respective fishery sites. In the flowing river sites a simple distribution principle is followed between owners of capital (net and boat) and labour. The capital owners receive 50% of the gross income or earnings and the remaining 50% is shared equally between all the members of the fishing unit irrespective of whether they are skilled or not. Since there is little exception to this distribution norm in the flowing rivers, it has been used here to calculate returns to labour.A value of 100 for the return to labour thus shows that the fishermen would earn the same in non-fishing activities as they do in their own fishing activities. Table 3 shows that even in the "off-season" fishermen's returns to labour or implicit wage incomes are significantly higher than those obtainable in other economic activities in all the flowing river sites. Here again a 50% adjustment factor has been used to compute the opportunity cost of labour. Thus, the calculation of the return to labour is sensitive to this surplus labour adjustment factor.

An implicit daily wage rate has also been calculated in Table 3. The fishermen's share (as labourers) of gross earnings is divided by the number of fishing mandays to yield an approximate daily wage rate. The mean wage rate thus computed, is highest in Padma-Jamuna followed sequentially by Narissa-Padma, Meghna and Meghna-Nayabhangni. It is clear that the return to labour is higher in fishing activities than in other income earning opportunities. This comparison provides a validation of the hypothesis that fishermen continue in their activities because they are relatively more remunerative. Fishermen are, therefore, more rational in an economic sense than they are normally believed to be.

As indicated earlier 3 out of the 4 flowing river fisheries are almost completely specialized in hilsa catch during this period. The *chandi jal* is, however, the only common hilsa gear found in all the river fisheries, during the period under consideration. The mean pure profit in *chandi* operation at Tk 38,746 in the DOF - intensively managed fishery, viz., Narisha-Padma, is by far the largest among all the four river sites. The pure profit in *chandi* operation is Tk 4,823, Tk 4,408 and Tk 1,680 in Padma-Jamuna, Meghna and Meghna-Nayabhangni fisheries respectively.

Technical efficiency and per unit profitability of fishing

Table 4 shows the computed mean CPUE's, catch rate and the cost per unit of effort in the flowing rivers. It

must be noted at the very outset that the technical efficiency parameters, i.e., CPUE's shown in Table 4 could be subject to seasonal fluctuation. These figures correspond to the seasonal low period. As expected, there is significant variation in the CPUE and catch rates across gears in each site and the variation is greater in some sites than in others. Abstracting away from the differences in gears and hence their respective CPUE's, we may focus on the average CPUE in each fishery site.

The CPUE is largest in the DOF managed sites, i.e, Narisha-Padma (0.38 kg) and Padma-Jamuna (0.39 kg). For each hour of fishing, the average catch

Table 4. Technical efficiency and cost of fishing by gear-type and fishery site.

Type of net (Location)	Catch rate (kg)	Catch per Unit of Effort (CPUE) (kg)	Cost per Unit of Effort (COPUE) (Tk)
(Meghna-Nayabhangni)			
Gill net (Chandi jal)	0.90	0.39	0.47
Gill net (Langta jal)	0.24	0.10	0.43
Beach seine net (Kona jal)	1.17	0.21	0.98
Gill net (Chani jal)	1.05	0.25	0.76
Gill net (Pait jal)	1.00	0.13	0.72
Mean location	0.99	0.24	0.76
Standard deviation location	0.68	0.25	0.58
Coefficient of variation	68.33	102.30	76.38
(Meghna)			
Gill net (Chandi jal)	1.16	0.21	0.64
Gill net (Dora jal)	1.55	0.24	0.72
Gill net (Langta jal)	0.73	0.29	0.63
Mean location	1.14	0.26	0.66
Standard deviation location	0.82	0.15	0.33
Coefficient of variation	71.36	116.16	49.88
(Narisha-Padma)			
Gill net (Chandi jal)	2.03	0.45	1.13
Gill net (Dora jal)	1.63	0.42	1.11
Dipnet (Vhel jal)	1.34	0.39	1.14
Clapnet (Shangla jal)	0.39	0.19	1.35
Gill net (Paich jal)	1.44	0.37	1.85
Seine net (Moi jal)	0.44	0.22	0.98
Small-mesh seine (Ghano ber jal)	3.41	0.32	1.00
Seine net (Cona ber jal)	1.88	0.28	1.96
Cast net (Zhaki jal)	1.73	0.87	1.08
Mean location	1.87	0.38	1.17
Standard deviation location	1.16	0.21	0.57
Coefficient of variation	62.05	55.10	48.96
(Padma-Jamuna-Balbonth)			
Gill net (Chandi jal)	1.83	0.29	1.04
Gill net (Dora jal)	1.46	0.41	1.06
Dipnet (Vhel jal)	2.56	0.43	0.72
Seine net (Moi jal)	1.00	0.14	0.83
Small-mesh seine (Ghano ber jal)	3.39	0.32	0.94
Dragnet (Shatting jal)	2.78	0.56	2.31
Mean location	1.80	0.39	1.06
Standard deviation location	0.92	0.20	0.45
Coefficient of variation	51.26	51.84	42.23

is 1.87 kg and 1.80 kg respectively, in these two fisheries. The coefficient of variation of CPUE is 55% and 51% respectively, in Narisha-Padma and Padma-Jamuna, while the co-efficient of variation of catch rate is 62% and 51% respectively. The mean CPUE is 0.39 kg and 0.38 kg in Padma-Jamuna and Narisha-Padma respectively. It is also very similar (0.25 kg) in the other two river sites. The relative dispersion of CPUE is similar in magnitude ranging from 51% to 58% in three fisheries except Meghna-Nayabhangni where it is 104% The mean CPUE of Meghna-Nayabhangni and Meghna are significantly different from the mean CPUE's of the two DOF-managed fisheries at the 1% level. The average catch rates in Meghna and Meghna-Nayabhangni are 1.14 kg and 0.99 kg, respectively.

Turning to the COPUE, measured as the product of cash cost per catch and catch per unit of effort, it is observed that in Narissa-Padma, the cost of each fishing man-hour is Tk 1.17 which is the highest, followed by Tk 1.06 in Padma-Jamuna. Both these fisheries are DOF-managed. In the LALR managed fisheries, the cost per unit effort is in the range of Tk 0.65-0.76. The cost per effort differences are significantly different from those of the DOF-managed fisheries at the 5% level. The average revenue of effort (ARE), defined as the product of price and CPUE, was also computed. Padma-Jamuna has the highest ARE of Tk 9.30 per fishing man-hour. Again the DOF sites have larger ARE's. The significant fact is that the average revenue of effort is much greater (several times) than the cost per effort. Under open access,ARE would tend to equal COPUE, i.e., the condition for bioeconomic equilibrium. The large positive differences between costs and revenue earned from each man-hour of fishing, may be attributed to the existence of regulation, i.e., licensing or control through the *ijaradar* system. The gross income per effort is Tk 8.24, Tk 4.98 and Tk 5.50 in Padma-Jamuna, Narisśa-Padma, Meghna and Meghna-Nayabhangni, respectively. Thus, the implied gross profits per 8 hours (a day) per fishermen works out at approximately Tk 66, Tk 53, Tk 40 and Tk 44 respectively. These are daily gross value-added rates. Their distribution between labour and capital has been discussed earlier.

Concluding Remarks

The study based on a survey of 199 fishing units in four riverine fishery sites indicated the prevalence of substantial pure profits and resource rents in the 30-day period under consideration (mid-December 1987 to mid March 1988) even though this was the off-season in these fisheries. The fish catch largely represented hilsa in all the four sites. The proportion of hilsa catch in total catch value in Meghna-Nayabhangni, Narissa-Padma, Padma-Jamuna and Meghna was 100%, 50% 31% and 100%, respectively. However, it should be borne in mind that the calculation of pure profit is sensitive to the adjustment made on account of shadow wage costs. The shadow wage conversion factor used in the present study is 0.50 reflecting a very high degree of unemployment in and around the fishery sites. The average pure profits were also found to be significantly higher in the DOF-managed sites, i.e., Narissa-Padma and Padma-Jamuna as shown by the statistical tests of differences between average pure profits across the fishery sites. However, further studies analyzing the determinants of these differences are necessary in order to be able to attribute the higher pure profits in DOF-managed sites to the strength of this particular type of management.

The high implicit wage rates clearly showed that fishing yields higher returns to labour relative to other economic activities. The evidence strongly indicates that fishing activity is undertaken by fishermen because it is relatively more profitable. High returns to capital investment and low pay-back periods are also evident mainly reflecting low capital costs in fishing activities undertaken in these fisheries.

The average CPUE in the DOF-managed fishery sites were 0.38 kg and 0.39 kg compared to 0.24 kg and 0.26 kg in the non-DOF fishing sites. Similarly, the catch rates in the DOF-managed sites (1.87 kg/hour and 1.80 kg/hour) were also substantially higher than the non-DOF fishery sites where they were 0.99 kg/hour and 1.14 kg/hour. The implied gross value-added per fishermen in an 8-hour working day is estimated at Tk 66, Tk 53, Tk 40 and Tk 44 in Padma-Jamuna, Narissa-Padma, Meghna-Nayabhangni river sites, respectively.

All computations in this study should be taken as indicative. Further work in these river sites is continuing which will provide more information and hence will help to improve the precision of the estimates made in this study. The strength of this study lies in providing a rigorous analytical framework allowing the estimation of detailed costs and returns of fishing activities and the estimation of the CPUE which is a very important policy parameter.

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Panel Discussion

Dr. Mahmudul Ameen
Professor, Department of Zoology
Dhaka University

In the first paper for this session, Professor M. Sekandar Khan described the present property system in inland fisheries and the property structure of fishing equipments (vessel, gear, etc.). He then analyzed the benefits and costs of fishing activities and income distribution from fishing.

His discussions are based mainly on two previous works: Ullah (1985)[a] and Khaled (1985)[b]. According to Ullah, the lease of a fishery is passed on to non-fishermen capitalists and that lease market is not as competitive as it may appear from leasing arrangements. He concluded that the River Jamuna is not an open-access fishery.

On the other hand, Khaled (1985) concluded that riverine fisheries of Bangladesh are characterized by free access. The leaseholder is not the operator in fishing and aims at maximizing the toll revenue, which is a fixed cost to fishermen.

Professor Khan then attempted to analyze the profit rate across different categories of fishing units. His general conclusion is that the rate of profit is same for all class of fishermen. It is the absolute profit that differs among rich and poor fishing units.

As for benefits generated by various gear, species and area of fishing, the following inferences were drawn:

* Use of fewer and smaller nets but more labour, and

* Earnings of labour and net exceeded the value of their marginal product whereas the inputed cost of boat fell short of the value of its marginal product.

* Input share value of labour, boat and net do not exhaust the revenue incomes and the residual accrues to the owner of boat and net.

* The above residual belongs to society as "rental from stock". Thus, there is a scope for further increasing the rental from license fees.

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a Ullah, M. 1985. Fishing rights, production relations, and profitability: a case study of Jamuna fishermen in Bangladesh, p. 211-221. In Panayotou, T. (ed.) Small-scale fisheries in Asia: socio-economic analysis and policy. IDRC, Ottawa, Canada.

b Khaled, M.S. 1985. Production technology of the riverine fisheries in Bangladesh, p. 113-120. In Panayotou, T. (ed.) Small-scale fisheries in Asia: socio-economic analysis and policy. IDRC, Ottawa, Canada.

But, a correct stock assessment is important and the labour cost should be regarded as wages and excluded from capital. Otherwise we may be repeating the Pakistani laws leading to further impoverisation and deprivation of the poor fishermen.

The rate of return in fishing has been found to be very high according to Ullah and Khaled. However, this would now depend on the present stock, area and effort of the fisheries.

For the above reason it is necessary to examine the information paper presented by Dr. S.H. Rahman carefully, especially the inferences drawn in it before making any final judgement.

In several places of the information paper, deficiency in the biological background is apparent. So the inferences need to be weighted. I intend to point out some of the inadequacies in this respect. Then, I shall try to indicate where the inferences should be modified before formulating recommendations which would have policy implications.

One cannot agree with the information paper that there is no intervention in the reproduction cycle and growth of various fish species inhabiting the natural fisheries system of Bangladesh. Flood Control Drainage (FCD) and Flood Control Drainange and Irrigation (FCDI) schemes have definitely intervened in the natural biology of the openwater fisheries.

Undisturbed openwater fisheries are components of what are called "flood plain river fisheries". The rivers within the Bangladesh territory are mostly mature rivers and their fisheries differ in quality from upland rivers. It is known from other parts of the world that the fisheries production of floodplain rivers is directly proportional to the extent and duration of floods. It was estimated for the Mekong river that human intervention reduced fisheries production by 10.8% for the whole river basin, 42.7% in the downstream section and 31.3 % in the brackishwater estuary section. However, the loss in the openwater sector can be compensated by developing culture fishery in the FCD and FCDI areas as in the Chandpur Irrigation Project area.

The information paper states that the inland open waters are made up of several interacting aquatic environments which have their own physical, topographical and ecological characteristics that show great diversity. Only three major inland open-water components have been recognized (rivers, *beels* and floodplain). But actually in the floodplain rivers all the systems are one during high flood and they separate out during the dry season. (Dr. Youssouf Ali also recorded this in his paper). This affects recruitment, total fish biomass and catch of various fisheries. I would consider that the open-water fisheries of Bangladesh have 6 major components, viz., (1) Freshwater zone of the rivers, (2) brackishwater zone of the rivers, (3) *beels*, (4) *haors* and *beel* system of the NE Bangladesh, (5) *baors* of the SW Bangladesh, and (6) the impounded lakes - Kaptai and Feni reservoirs.

The inferences of the information paper appear to be based mainly on the hilsa fishery whose crafts, gears and fishing grounds are rather specialized. Hence it would not be wise to draw any general conclusions for other fisheries on the basis of the hilsa fishery.

It is true that the inland open-water fishery systems have not been studied widely, particularly within the inter-disciplinary framework. However, the works on the floodplain river systems of Africa, South America, the Danube and the Mekong have provided certain empirical formulae. Access to these could have made it easier to prepare the present paper.

One of the commonest concepts for the regulation of fisheries is that of maximum sustainable yield (MSY) as discussed in the information paper. But the concept is applicable mainly to single stocks whose abundance is relatively unaffected by changes in the environment. MSY has lately been somewhat discredited because few fisheries are typical of the above situation, and "as it introduces severe economic weaknesses in that it is heavily biased towards long-term situation" (Welcomme 1979)[a]. The concept is particularly inappropriate to river fisheries as they are based on multispecies communities whose abundance is largely determined by an environmental variable, the flood intensity. It is very difficult to find simple replacement whereby to manage the fishery. In its place one can offer the generalization that a certain amount per unit area can be caught, or can select somewhat arbitrary management measures based on the knowledge of the fishery itself and other fisheries. This has been attempted in other parts of the world.

One of the ideas behind the Experiments in New Approaches to the Improved Management of Open-water Fisheries in Bangladesh (ENIMOF) workshop is to improve the economic condition of the poor fishermen. But if I have not misunderstood this has somewhat been neglected in the economic analysis.

* One of the conclusions in the paper is that the difference between gross income and profit in openwater fishery is small as there is no cash wage payment. Self-labour was not accounted for in the financial analyses but was valued at its shadow price in economic analyses. But this has also been taken as the capital of the fishery labours. Wages are necessary for sustenance. So I wonder how these can be capital?

* "Very low or negative pure profits reflect resource exhaustion in a given fishery, i.e., that the current catch effort levels are beyond or around the bionomic equilibrium levels. This, however, does not appear to be the case in the flowing rivers even in the "off-season".

a) The exercise is on hilsa fishery alone.

b) It is not clear whether the wages of the labourers were deducted in calculating profits?

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a Welcomme, R.L. 1979. Fishery management in large rivers. FAO Fish. Tech. Pap. 194, 60 p. FAO, Rome.

* The monthly rates of return to capital investment (boat and gear) are very high. The investment pay-back period is approximately 1.5 to 6 months.

This shows that the boat-gear owners/leaders/non-fishermen get most of the profits, not the poor fishermen.

* "Free-of-cost" nature of fish resources may lead to expanded fishery effort to socially undesirable levels. A charge of rental (user cost) to fishermen would reduce efforts and ensure conservation of fisheries resources and maximize economic benefits to society. I agree that licensing would tend to conserve more than the present leasing system. But the rate of license should not be uniform for all species, gear and fisheries components for reasons discussed earlier.

Another factor has not been treated in either of the papers, i.e., that of the intermediaries in marketing fisheries catch. The information paper records "Fish marketing in Bangladesh is characterized by a long and intricate chain of intermediaries".

The role of intermediaries and distribution of benefits therefrom have important roles in society as a whole. This factor, i.e., the marketing of fisheries products, deserves more in depth analyses and corrective measures.

So the main conclusions should be:

* Licensing is a better management practice than leasing.

* The licensing fees should be determined for the kinds of fishery, gears and crafts. More judicious economic analyses are necessary before fixing fees because they can not be changed often.

* Consequences on the poor fishermen should be very carefully and sympathetically considered.

* Crafts and gears should be available through institutional organization and management to all real fishermen so that the profit distribution is even among the members of a team.

Dr. Aminul Islam
Director
Fisheries Research Institute (FRI)

The open-water capture fishery contributes significantly to the total fish production of the country. Open-water fisheries have been showing a declining trend in the recent years. Formulation and implementation of location specific management policy are considered to sustain and enhance fish production as well as to improve economic conditions of the fishermen.

The two papers presented by Prof. Sekandar Khan and Dr. S.H. Rahman are both well written. Professor Khan attempted to present the situation prevailing in the sector, while Dr. Rahman attempted to analyze the costs and returns from fishing. Both the paper highlighted the various complex systems involved in

the open water fishing. However, in calculating benefits from fisheries and their distribution, other economic activities related to fisheries require to be considered are:

* Fishing gear and craft making
* Spawn collection
* De-heading of shrimp
* Ice-breaking
* Fish processing, especially shrimp freezing and fish drying
* fish trade, etc.

Some of these activities have changed the entire economic pattern of some of the areas in the countryside.

RECOMMENDATIONS

The purpose of the workshop was to review experiences gained and discuss results obtained during the first year of the implementation on experimental basis of the NFMP in selected water bodies being monitored and evaluated under the ENIMOF Project. The workshop also drew on inputs from papers presented by national and international experts. A lively discussion followed the various presentations whose views, comments and suggestions were considered by a Recommendation Committee formed by the MOFL in the preparation of these recommendations. This Committee consisted of the following members:

Dr. Max Agüero
Associate Scientist
International Center for Living Aquatic Resources Management (ICLARM)
Manila
Philippines

Mr. Kazi Azizul Haq
Principal Scientific Officer
Marine Fisheries Development Project
Chittagong, Bangladesh

Mr. Liaquat Ali
Chief Scientific Officer
Baor Project
Matshya Bhaban, Dhaka
Bangladesh

Dr. Saleemul Haq
Executive Director
Bangladesh Centre for Advanced Studies (BCAS)
Dhanmondi, Dhaka
Bangladesh

Dr. M. Youssouf Ali
Team Leader
ENIMOF Project Monitoring Team
Dhaka
Bangladesh

Dr. Atiq Rahman
Director
Bangladesh Centre for Advanced Studies (BCAS)
Dhanmondi, Dhaka
Bangladesh

Rationale for recommendations

The Recommendation Committee met a number of times and compiled all the recommendations made by participants at the workshop selecting a maximum of 16 recommendations, according to the following criteria:

- Relevance and pertinence to the subject of the seminar i.e. management of open-water inland fisheries.

- Relevance to the session topics, i.e. (a) environment and sustainability of fish resources (b) survey and data gathering (c) licensing *vs* leasing and (d) factor ownership and distribution of benefits.

- Implementation possibility of benefits i.e. recommendations should be actionable by the relevant authorities, e.g., Department of Fisheries, Ministry of Fisheries and Livestock, etc.

Using the above guidelines, the Recommendation Committee selected the following recommendations which are listed along with a brief rationale for each recommendation.

A. Environment and Sustainability of Fisheries Resources

The threat to the sustainability of inland water fisheries resources that these environmental impacts are producing was well appreciated during the workshop and the following recommendations were proposed by the Committee:

1. A number of human interventions are adversely affecting fish habitats, the main ones being: i) agrochemical and industrial pollution, ii) closing of rivers and channels and iii) flood control and drainage projects which prevent the fish from spreading from the river to the flood plain which is often the rearing and breeding grounds. Such interventions (e.g. FCD, FCDI, embankments, industries, pesticides, etc.) should be regulated so that the possible adverse impacts on fishery resources, fishermen's livelihoods and nutritional requirement of the people are taken into account.

2. The study of the sustainability of fisheries resources, particularly open-water capture fisheries, is extremely difficult and time consuming, but nevertheless necessary if the resources are to be rationally exploited at sustained levels. Thus, long-term studies of the potentials of inland open-water habitats of important fish species must be strengthened and increased. The efforts of the ENIMOF Monitoring Team in this regard are a very useful start and should be continued as a second phase of the activity for at least five years to give reliable results for policy makers.

3. Fishing effort should be properly regulated to avoid situations where the sustainability of resources may be threatened. This can be done by making the costs of fishing effort fully reflect the scarcity value of the resource. Thorough bio-economic studies based on reliable field data should be conducted to provide required information to policy makers.

4. It was agreed that the fisheries resources of the inland open-water capture fisheries have crossed the limits of sustainability in many cases and will not be able to expand unless interventions are made to enhance productivity. Therefore, steps should be taken to increase the fisheries resources through such efforts as supplemental stocking of open-water bodies, protection of segments of open-water bodies which are breeding grounds for important fish species, observing close season for pertinent species, mesh size regulation, etc.

B. Survey and Data Gathering

The workshop recognized that the state of knowledge regarding the fisheries sector of the country is inadequate considering the importance of this sector in terms of the production, export earnings and employment. Therefore, efforts in this regard should be strengthened.

1. It is recommended that a national fisheries resources survey should be undertaken to determine both the biological and socioeconomic status of the sector. It is suggested that the data and information obtained in these surveys should be recorded, analyzed and disseminated on regular basis. For this purpose, fisheries related information may be generated and included in the national agricultural statistics and related bulletins.
2. The capabilities of the Fisheries Resource Survey System need to be enhanced in terms of more expert manpower, technical skills and computing facilities.
3. Publication and dissemination of the results of such surveys should be done in coordination with other concerned agencies to avoid errors and duplications, as well as to promote standardization.
4. The Committee recommends the implementation of training and technical assistance programs to be provided by international research institutes with experience in this field, particularly in the areas of fisheries biology, management and sociocultural aspects of small-scale fishing communities.

C. Licensing *versus* Leasing

It was generally agreed that the New Fisheries Management Policy regarding open-water inland fisheries was a breakthrough in terms of providing equity and benefits to genuine fishermen. Therefore, it was felt that this policy should be extended as planned. However there remained a number of problems which needed to be addressed in the future to make it a genuine success. The following recommendations were selected to address these problems:

1. Coordination between the different concerned Ministries and Departments must be properly institutionalized both at the national as well as the local level. For this purpose, the Ministry of Fisheries and Livestock and the Ministry of Lands should meet regularly to coordinate their efforts towards successful implementation of the policy.
2. Lack of credit for small-scale fishermen has been a major problem of the fishermen in Bangladesh. They need to be better organized for institutional credit arrangements. It is recommended that the NGOs be utilized in organizing fishermen and providing/channeling necessary credits, although commercial or development banks should take over such provisions in the long-run.
3. The awareness, motivation and knowledge of the field level DOF officials about the objectives and rationale of the NFMP need to be enhanced. For this purpose regular training workshops of DOF field personnel should be instituted.

4. As the implementation of NFMP considerably increased the duties and responsibilities of the field level officials requiring improved logistics and additional financial resources, it is recommended that proper budgets for these additional activities be ensured.

5. Given that encouraging results have been obtained during the short period of implementation of ENIMOF Project, it is recommended that the ongoing effort be supplemented with more effective mechanisms.

D. Factor Ownership and Distribution of Benefits

The Committee recognized that the majority of the fishermen do not have boats, gear and other equipment of their own. Normally, a few rich fishermen own these inputs and receive a very high percentage of fishing income as rent or input share. The general fishermen often receive a barely minimum amount of income as share of their labour. This has caused a biased distribution of benefits.

On the other hand, it was alleged that the fees charged for the licenses are not uniform and have not been based in proper economic assessment of the value of the fish resources.

The committee, therefore recommends the following:

1. Government's direct subsidy and support programmes for the economic upliftment of the rural poor should include fishermen as a target group and more support should be chanelled to them.

2. In implementing the NFMP, the management authority should also insist on a more equitable distribution of fishing income among input owners and labour fishermen. The government should provide mechanisms for the fishermen to acquire fishing inputs.

3. The licensing system should be commensurate with scarcity value of the resource and these values have to be computed on the basis of good field data.

Conclusion

The recommendations which have been included above have been selected to address the issue of management of open-water inland capture fisheries and reflect the suggestions and comments made by the authors, discussants and participants during the seminar. The recommendations are directed towards policy planners, donors, fisheries officials and the scientific community for their consideration and implementation.

Summary Recommendations

I. Environment, Conservation and Fishery Resources

1. Human intervention/damage to the fishery resource through chemical discharge, industrial pollution, blocking water/fishways, construction of FCD and FCDI should be monitored and controlled.
2. The effort of ENIMOF in monitoring the fishery situation should be continued to provide reliable results for policy makers.
3. Strict enforcement of the Fish Act, and provision of adequate manpower for implementation of NFMP principles should be ensured.
4. Conservation and propagation of resources should be ensured through supplementary stocking and protection by specific regulation e.g., close-season, close-area, mesh size, etc.

II. Survey and Data Collections

1. A national fishery census be undertaken including socioeconomic data.
2. Strengthening the data gathering, analysis and reporting capability through training of personnel and provision of better facilities.
3 Fisheries data should be regularly published and disseminated.
4. Cooperation and complementarity of the different national and international agencies involved should be ensured.

III. Licensing *versus* Leasing

1. The licensing system under NFMP has shown beneficial effects to poor fishermen and should be extended.
2. Necessary credits to poor fishermen should be provided from institutional sources. Creation of a separate Fishery Bank is proposed for this purpose with increased NGO involvement.
3. Conservation of fish stocks should be better addressed in the NFMP.
4. DOF field level management personnel should be given training as well as facilities to strengthen their management capabilities and increase their effectiveness.
5. Infrastructure, training, extension and organization of fishermen should be promoted through institutional efforts.

IV. Factor Ownership and Distribution of Benefits

1. Direct subsidy and support for poor fishermen should be provided.
2. Sharing of benefits within the fishermen group should be more equitable.
3. The licensing system should commensurate with scarcity value of the resource.

The Recommendation Committee
May 1989

List of Participants and Observers

Inaugural Session Speakers

Mr. Mohammed Ahsanullah
Director
Department of Fisheries
Matshya Bhaban, Park Ave.,
Ramna, Dhaka
Bangladesh

Dr. Charles Bailey
Representative
The Ford Foundation
P.O. Box 98
Ramna, Dhaka
Bangladesh

Mr. Mokammel Haq
Secretary
Ministry of Lands
Bangladesh Secretariate, Dhaka
Bangladesh

Mr. Sardar Amjad Hossain
Minister of Fisheries and Livestock
Bangladesh Secretariate, Dhaka
Bangladesh

Dr. Quamrul Islam
President
Jatiya Matshyajibi Samity
Dhaka
Bangladesh

Mr. Md. Ahsan Ali Sarkar
Joint Secretary
Ministry of Fisheries and Livestock
Bangladesh Secretariate, Dhaka
Bangladesh

Mr. Mokammel Hossain
Project Director (ENIMOF)
Department of Fisheries
Matshya Bhaban, Park Ave.
Ramna, Dhaka
Bangladesh

Resource Speakers

Dr. Max Agüero
Associate Scientist
International Center for Living
Aquatic Resources Management
MC PO Box 1501
Makati, Metro Manila
Philippines

Mr. Md. Liaquat Ali
Deputy Director of Fisheries
Department of Fisheries
Khulna Division, Khulna
Bangladesh

Dr. M. Youssouf Ali
Senior Project Coordinator
ENIMOF Project
6th Floor, Matshya Bhaban,
Park Ave., Dhaka
Bangladesh

Prof. A.K.M. Aminul Haque
Ex-Vice Chancellor
Bangladesh Agricultural University
Mymensingh
Bangladesh

Mr. M. Sekandar Khan
Professor
Department of Economics
Chittagong University, Chittagong
Bangladesh

Dr. Syed Ali Naqi
Associate Professor
Department of Sociology
Dhaka University, Dhaka
Bangladesh

Dr. A.K.M. Nuruzzaman
Member-Director (Fisheries)
Bangladesh Agricultural Research Council
Farm Gate, Dhaka
Bangladesh

Mr. A.K. Ataur Rahman
Joint-Director
Department of Fisheries
Matshya Bhaban, Park Ave.
Ramna, Dhaka
Bangladesh

Dr. Sultan H. Rahman
Director
Bangladesh Centre for Advanced Studies
Dhanmondi, Dhaka
Bangladesh

Dr. Kamal Siddiqui
Director General
Institute of Local Government
Agargaon, Dhaka
Bangladesh

Session Chairmen

Mr. Mohammed Ahsanullah
Director
Department of Fisheries
Matshya Bhaban, Park Ave.,
Ramna, Dhaka
Bangladesh

Mr. Altaf Ali
Divisional Chief, Planning Commission
Ministry of Planning
Sherebangla Nagar, Dhaka
Bangladesh

Mr. A.H. Abdul Quder Chowdhury
Additional Director
Department of Fisheries
Matshya Bhaban, Park Ave.
Ramna, Dhaka
Bangladesh

Mr. Lutful Lahil Majid
Chief Controller Export & Import
Chief Controller Office
Matijheel Commercial Area, Dhaka
Bangladesh

Mr. A.Z.M. Nasiruddin
Secretary
Ministry of Fisheries and Livestock
Bangladesh Secretariate, Dhaka
Bangladesh

Panelists

Dr. Qazi Faruqe Ahmed
Director
Proshika Manobik Unnayan Kendra
Iqbal Road, Dhaka
Bangladesh

Dr. Mahmudul Ameen
Professor
Department of Zoology
Dhaka University, Dhaka
Bangladesh

Dr. Mahabub Hossain
Director General
Bangladesh Institute of Development Studies
Dhaka, Bangladesh

Dr. Kazi Zaker Hossain
Professor
Department of Zoology
Dhaka University, Dhaka
Bangladesh

Dr. Aminul Islam
Director
Fisheries Research Institute
Mymensingh
Bangladesh

Mr. M.A.H. Pramanik
Chairman
Bangladesh Space Research and Remote Sensing Organization
Sherebangla Nagar, Dhaka
Bangladesh

Dr. M. Mahbubur Rahman
Action Research Fellow
Centre for Integrated Rural Development for Asia and the Pacific
Chameli House, Dhaka
Bangladesh

Mr. M.A. Samad
Director General
Implementation, Monitoring and Evaluation Department
Sherebangla Nagar, Dhaka
Bangladesh

Observers

Mr. Jafar Ahmed
District Fishery Officer
Sylhet
Bangladesh

Mr. Lokman Ahmed
Joint Chief
Ministry of Fisheries and Livestock
Bangladesh Secretariate, Dhaka
Bangladesh

Mr. Khabiruddin Ahmed
District Fishery Officer
Gopalganj
Bangladesh

Mr. Shafiuddin Ahmed
Principal Scientific Officer
Department of Fisheries
Matshya Bhaban, Park Ave.
Ramna, Dhaka
Bangladesh

Mr. Sariful Islam Akhand
District Fishery Officer
Kurigram
Bangladesh

Mr. Syed Khairul Alam
Deputy Director
MOFL Information Department
Khamar Bari, Farm Gate
Dhaka
Bangladesh

Advocate Islam Ali
General Secretary
Jatiya Mayshyajibi Samity
Dhaka, Bangladesh

Mr. Mohsin Ali
Chief Scientific Officer
Matshya Bhaban, Dhaka
Bangladesh

Mr. Shawkat Ali
Chief Fisheries Extension Officer
Department of Fisheries
Matshya Bhaban, Park Ave.
Ramna, Dhaka
Bangladesh

Mr. Syed Iqbal Ali
Deputy team Leader
Bangladesh Centre For Advanced Studies
Dhanmondi, Dhaka
Bangladesh

Mr. G.K.S.M. Syed Amin
District Fishery Officer
Chittagong
Bangladesh

Mr. Ruhul Amin
Deputy Secretary
Ministry of Fisheries and Livestock
Bangladesh Secretariate, Dhaka
Bangladesh

Mr. Md. Amirullah
District Fishery Officer
Jhalukati
Bangladesh

Mr. Ali Azam
District Fishery Officer
Tangail
Bangladesh

Mr. Abdul Aziz
District Fishery Officer
Madaripur
Bangladesh

Mr. Sarif Abu Bakar
District Fishery Officer
Sariatpur
Bangladesh

Mr. R.C.K. Banik
Senior Scientific Officer
Bangladesh Fisheries Resources
Survey System
Matshya Bhaban, Park Ave.
Ramna, Dhaka
Bangladesh

Ms. Hosneara Begum
District Fishery Officer
Gazipur
Bangladesh

Ms. Morjina Begum
Upazila Fishery Officer
Goalondo, Rajbari
Bangladesh

Ms. Tahmina Begum
Asst. Secretary
Ministry of Fisheries and Livestock
Bangladesh Secretariate, Dhaka
Bangladesh

Mr. Rokibuddin Biswas
Research Officer (PI)
Department of Fisheries
Matshya Bhaban, Park Ave.
Ramna, Dhaka
Bangladesh

Mr. Soydeb Kumar Biswas
District Fishery Officer
Chuadhanga
Bangladesh

Mr. A.Z.M. Obaidulhaque Bhyian
District Fishery Officer
Comilla
Bangladesh

Mr. Arjun Chandra Chanda
Deputy Asst. Director
Matshya Bhaban, Dhaka
Bangladesh

Mr. Delwar Hossain Chowdhury
District Fishery Officer
Kushitia
Bangladesh

Mr. Sitesh Chandra Chowdhury
Fishery Survey Officer
Department of Fisheries
6th Floor, Matshya Bhaban
Park Ave., Dhaka
Bangladesh

Mr. Wahidun Nabi Chowdhury
District Fishery Officer
Feni
Bangladesh

Mr. Shwpan Dev
District Fishery Officer
Nilfamari
Bangladesh

Ms. Zerina Ekram
Project Secretary
ENIMOF Project
Department of Fisheries
6th Floor, Matshya Bhaban
Park Ave., Dhaka
Bangladesh

Mr. Mridul Das Gupta
District Fishery Officer
Noakhali
Bangladesh

Mr. Ehtheshum Karim Habib
District Fishery Officer
Serajganj
Bangladesh

Mr. A.S.M. Motaharul Haque
District Fishery Officer
Rajbari
Bangladesh

Mr. Kazi Azizul Haque
Project Director
Marine Fisheries Project
#2, 6th Floor
C.G.O. Building
Agrabad, Chittagong
Bangladesh

Mr. Md. Anwarul Haque
District Fishery Officer
Rahshahi
Bangladesh

Mr. Md. Mahbubul Haque
District Fishery Officer
Bogura
Bangladesh

Mr. Nazirul Haque
Deputy Director of Fisheries
Comilla
Bangladesh

Mr. Akter Hossain
District Fishery Officer
Nababganj
Bangladesh

Mr. Amir Hossain
District Fishery Officer
Barisal
Bangladesh

Mr. Anwar Hossain
Asst. Director
Department of Fisheries
Matshya Bhaban, Park Ave.
Ramna, Dhaka
Bangladesh

Dr. Saleemul Huq
Executive Director
Bangladesh Centre for Advanced Studies
Dhanmondi, Dhaka
Bangladesh

Mr. Zahidul Huq
Upazila Fishery Officer
Hizla, Barisal
Bangladesh

Mr. Zahirul Huq
Deputy Director
Implementation, Monitoring
and Evaluation Department
Dhaka
Bangladesh

Mr. Md. Mofaqkarul Islam
District Fishery Officer
Gaibanda
Bangladesh

Mr. Nazrul Islam
Deputy Chief (Planning)
Department of Fisheries
Matshya Bhaban, Park Ave.
Ramna, Dhaka
Bangladesh

Mr. S.M. Nazmul Islam
District Fishery Officer
Manikganj
Bangladesh

Mr. Serajul Islam
District Fishery Officer
Jessore
Bangladesh

Mr. Tazul Islam
District Fishery Officer
Lakhmipur
Bangladesh

Mr. Kazi Jamaluddin
Chief Scientific Officer
Department of Fisheries
Matshya Bhaban, Park Ave.
Ramna, Dhaka
Bangladesh

Mr. Abdul Jalil
District Fishery Officer
Pabna
Bangladesh

Mr. Kazi Abul Kalam
District Fishery Officer
Patuakhali
Bangladesh

Mr. Serajul Karim
District Fishery Officer
Moulvibazar
Bangladesh

Mr. Bhuiya S.H.M. Kashem
Scientific Officer
Department of Fisheries
Matshya Bhaban, Park Ave.
Ramna, Dhaka
Bangladesh

Mr. Abdul Khalek
Upazila Fishery Officer
Jessore
Bangladesh

Mr. Abdul Khaleque
District Fishery Officer
Khulna
Bangladesh

Mr. Abdul Khaleque
District Fishery Officer
Mymensingh
Bangladesh

Mr. A.M. Khan
Modelling Expert
Bangladesh Centre for Advanced Studies
Dhanmondi, Dhaka
Bangladesh

Mr. Abdul Latif Khan
District Fishery Officer
Panchagor
Bangladesh

Ms. Asmeen Mariam Khan
Asst. Program Officer
The Ford Foundation
PO Box 98
Ramna, Dhaka 1000
Bangladesh

Mr. Giash Uddin Khan
Senior Scientific Officer
Marine Fisheries Project
2, 6th Floor
C.G.O. Building
Agrabad, Chittagong
Bangladesh

Mr. Mashiur Rahman Khan
Fishery Information Officer
MOFL Information Department
Khamar Bari, Farm Gate, Dhaka
Bangladesh

Mr. Md. Mohiuddin Khan
District Fishery Officer
Natore
Bangladesh

Mr. Shikder Chotur Krishna
District Fishery Officer
Bagerhat
Bangladesh

Mr. Abdul Malek
District Fishery Officer
Munshiganj
Bangladesh

Mr. Hasan Mahmood
District Fishery Officer
Chandpur
Bangladesh

Mr. Abdul Mannan
District Fishery Officer
Dinajpur
Bangladesh

Mr. Abdul Mazid
Chief Scientific Officer
Fisheries Research Institute
Mymensingh
Bangladesh

Mr. Ershad Miah
District Fishery Officer
Sunamganj
Bangladesh

Mr. Md. Momtaj Hossain Miah
District Fishery Officer
Lalmonirhat
Bangladesh

Mr. Mofizuddin
Upazila Fishery Officer
Kotiadi, Kishoreganj
Bangladesh

Mr. Mohiuddin
District Fishery Officer
Narshindi
Bangladesh

Mr. Shahjahan Mollah
District Fishery Officer
Barguna
Bangladesh

Mr. Ramesh Chandra Mondol
District Fishery Officer
Netrokona
Bangladesh

Mr. Golam Mostafa
Scientific Officer
Marine Fisheries Project
#2, 6th Floor
C.G.O. Building
Agrabad, Chittagong
Bangladesh

Mr. Abdul Motin
District Fishery Officer
Thakurgaon
Bangladesh

Mr. Shahnewaj Munshi
District Fishery Officer
Naowga
Bangladesh

Mr. S.K. Pal
Principal Scientific Officer
Bangladesh Agricultural Research Council
Farm Gate, Dhaka
Bangladesh

Ms. Ferdous Pervin
District Fishery Officer
Narayangan
Bangladesh

Mr. Md. Rafiquzzaman
Upazila Fishery Officer
Sunamganj
Bangladesh

Mr. Md. Reazuddin
Upazila Fishery Officer
Harirampur, Manikganj
Bangladesh

Mr. Ataur Rahim
Deputy Director of Fisheries
Rajshahi
Bangladesh

Mr. Abdur Rahman
Asst. Chief
Ministry of Fisheries and Livestock
Bangladesh Secretariate, Dhaka
Bangladesh

Prof. Asadur Rahman
Vice Chancellor
Bangladesh Agricultural University
Mymensingh
Bangladesh

Mr. Atiq Rahman
Environmental Planner
Bangladesh Centre for Advanced Studies
Dhanmondi, Dhaka
Bangladesh

Mr. Bazlur Rahman
District Fishery Officer
Habiganj
Bangladesh

Mr. Lutfur Rahman
District Fishery Officer
Keshoreganj
Bangladesh

Mr. Md. Mahfuzur Rahman
District Fishery Officer
Sherpur
Bangladesh

Mr. Md. Mizanur Rahman
Upazila Fishery Officer
Mehendiganj, Barisal
Bangladesh

Mr. Mizanur Rahman
Deputy Director of Fisheries
Dhaka
Bangladesh

Mr. Mozibur Rahman
District Fishery Officer
Noakhali
Bangladesh

Mr. Oliur Rahman
Upazila Fishery Officer
Sarsa, Jessore
Bangladesh

Mr. Tabibur Rahman
Deputy Project Director
Department of Fisheries
Baluhar Baor, Kotchandpur
Jessore
Bangladesh

Mr. A.K.M. Lutfur Rehman
Upazila Fishery Officer
Sadarpur, Faridpur
Bangladesh

Mr. Golam Roshul
District Fishery Officer
Jhenedah
Bangladesh

Mr. Sattendra Nath Saha
District Fishery Officer
Faridpur
Bangladesh

Mr. Syed Uddin Sarkar
District Fishery Officer
Norail
Bangladesh

Mr. Harendro Nath Sarker
Upazila Fishery Officer
Muladi, Barisal
Bangladesh

Mr. Abdus Sattar
District Fishery Officer
Dhaka
Bangladesh

Mr. Salma Sayeed
Scientific Officer
Department of Fisheries
Matshya Bhaban, Park Ave.
Ramna, Dhaka
Bangladesh

Mr. Serajuddin
District Fishery Officer
Cox's Bazar
Bangladesh

Prof. Md. Shafi
Fisheries Biologist
Bangladesh Centre for Advanced Studies
Dhanmondi, Dhaka
Bangladesh

Mr. Md. Shahidullah
Fisheries Technologist
Bangladesh Centre for Advanced Studies
Dhanmondi, Dhaka
Bangladesh

Mr. Md. Shahidullah
Dohar, Dhaka
Bangladesh

Mr. Abu Bakar Siddique
District Fishery Officer
Joypurhat
Bangladesh

Mr. Kazi Masum Siddique
System Analyst (ENIMOF)
Department of Fisheries
Matshya Bhaban, Park Ave.
Ramna, Dhaka
Bangladesh

Ms. Rebeka Sultana
Asst. Secretary
Ministry of Lands
Bangladesh Secretariate, Dhaka
Bangladesh

Mr. S.M. Suruzzaman
Upazila Fishery Officer
Charbhadrasan, Faridpur
Bangladesh

Mr. Rafiqul Islam Talukdar
District Fishery Officer
Jamalpur
Bangladesh

Mr. Finn Thilsted
Counceller
Danida Mission
Road 51, House 1
Gulshan, Dhaka
Bangladesh

Mr. Momtaz Uddin
Deputy Chief (Training)
Department of Fisheries
Matshya Bhaban, Park Ave.
Ramna, Dhaka
Bangladesh

Appendix 1
Glossary of Bengali Terms[a]

Aassalamu Alaikum	Peace be upon you (traditional Bangladeshi way of greeting)
arat	fish landing place (market) where fishermen bring their catch for auction sale to intending wholesale buyers
aratdars	agents in the channel of distribution of harvest who work on behalf of the merchant middlemen. They negotiate between intending buyers and sellers, arrange auctions and provide marketing facilities
Bangladesh Zinbabad	Long live Bangladesh
baor	ox-bow lake or dead river (segment of rivers cut-off from the mainstream flowing river)
beel	deeper portion in a low-lying natural depression area
bhasan	floating
chandi jal	a type of gillnet for Hilsa fishing
chingri mohol	area devoted to shrimp culture
dadon	advance money paid to fishermen
debottar	refers to properties belonging to temples to support worship of Hindu duties
faria	middlemen's agent
haor	low-lying natural depression area
hariken	locally made kerosene lamp
ijaradar	lease holder
jal jar jala tar	he who has net is the owner of the water body
jol-bagicha	aqua-garden
jalkar	a designated fishing ground
jalmahal	a designated fishing ground
Janab	Sir
jogot ber jal	seine net
jotdar	landlord
khal	channel or canal
khas	government-owned area

a This glossary does not include Bengali terms of fish. These can be found in the List of Important Fish and Prawns, Appendix 3, p. 142.

Khoda Hafez	a traditional Bangladeshi way of saying "goodbye"
kotchal	a method of group fishing which is formed by assembling the nets contributed by each member in the group for fishing in a particular fishing area
kumar	a fishing technique which involves the building of brush-shelters on fishing and subsequently organize fishing within the perimeter of the brushes
lakh	one hundred thousand
mache-bhate Bangalee	a Bangladeshi is said to be contended with rice and fish
matshya gram	fishermen village
maurasi jalkar	privately-owned water body (e.g., segemnt of a river or *beel)*
jalkar	goverrntment-owned fishing ground
nazarana	tax or honorarium
neerodyan	aqua-garden
nikari	local middleman
paiker	distributor who purchase fish from traders through *aratdars* at some wholesale points and sell it in the distant or remote urban or rural markets
pourashava	municipality
parishad	council
sariatmohal	goverrntment-owned fishing ground
sudra	low caste Hindu
sundarban	mangrove area
Taka (Tk)	currency unit in Bangladesh, 1 US $ = Tk 32
tashil	area designated under the ownership of *zamindars*
tashildar	tax collector in a designated area within a *tashil*
thoga jal	weir or net placed across the width of a river for catching fish during the dry season
upazila	local self government/administrative unit; level below the district usually including 150-175 villages and around 200,000 people
zamindar	landlord

Appendix 2
List of Acronyms

APDC	Asian and Pacific Development Centre
BARC	Bangladesh Agricultural Research Council
BAU	Bangladesh Agricultural University
BBS	Bangladesh Bureau of Statistics
BCAS	Bangladesh Centre for Advanced Studies
BFDC	Bangladesh Fisheries Development Corporation
BFRSS	Bangladesh Fisheries Resources Survey System
BIDS	Bangladesh Institute of Development Studies
BJMSS	Bangladesh Jatiya Matshyajibi Samabaya Samity Ltd.
BKB	Bangladesh Krishni Bank
BOBP	Bay of Bengal Programme
BPATC	Bangladesh Public Administration Training Center
BRDB	Bangladesh Rural Development Board
BWDB	Bangladesh Water Development Board
CARITAS	An NGO that channels funds donated by Catholic church for social and economic progress in the developing countries.
CIRDAP	Centre on Integrated Rural Development for Asia and the Pacific
DANIDA	Danish International Development Agency
DEPC	Department of Environmental Pollution Control
DFO	District Fishery Officer
DOF	Department of Fisheries
EBSATA	East Bengal State Acquisition and Tenancy Act of 1950
EEZ	Exclusive Economic Zone
ENIMOF	Experiments in New Approaches to the Improved Management of Open-water Fisheries in Bangladesh
ERD	External Resources Division
ESCAP	Economic and Social Commission for Asia and the Pacific
FAO	Food and Agriculture Organization
FCD	Flood Control Drainage
FCDI	Flood Control Drainage and Irrigation
FRI	Fisheries Research Institute
GOB	Government of Bangladesh

ICLARM	International Center for Living Aquatic Resources Management
IDRC	International Development Research Centre
IFDP	Irrigation Fisheries Development Programme
IMED	Implementation, Monitoring and Evaluation Department
INFS	Institute of Nutrition and Food Science
KPM	Karnafuly Paper Mills
LALR	Land Administration and Land Reform
MCI	Ministry of Commerce and Industries
MIFC	Ministry of Irrigation and Flood Control
ML/MOL	Ministry of Lands
MLGRD	Ministry of Local Government, Rural Development and Cooperatives
MOA	Ministry of Agriculture
MOE	Ministry of Education
MOFL	Ministry of Fisheries and Livestock
MPO	Master Plan Organization
NFMP	New Fisheries Management Policy
NGO	Nongovernmental Organization
NILG	National Institute of Local Government
PROSHIKA	Proshika Manobik Unnayan Kendra
SPARSSO	Bangladesh Space Research and Remote Sensing Organization
UCCs	*Upazila* Central Cooperative Associations
UFO	*Upazila* Fishery Officer
UNDP	United Nations Development Programme
UNO	*Upazila Nirbahi* Officer
UP	Union *Parishad*
UZP	*Upazila Parishad*

Appendix 3
List of Important Fish and Prawns Harvested from Inland Open Waters of Bangladesh[a]

Common Name	Family	Species	English Name	Habitat
Air	Bagridae	*Mystus aor*		F
		Mystus seenghali		F
Angrot	Cyprinidae	*Labeo angra*		F
Arwari	Bagridae	*Mystus menoda*		F
Baacha	Schilbeidae	*Eutropiicthys vacha*		F
Bagh aor	Bagariidae	*Bagarius bagarius*		F
Bailla	Gobiidae	*Awaous grammepomus*	Scribbled goby	M
		Awaous stamineus		M
Baim	Mastacembelidae	*Mastacembelus armatus*	Spiny eel	F, B
Baitka	Cyprinidae	*Labeo pangusia*		F
Banspata	Cyprinidae	*Danio devario*		F
	Mugilidae	*Liza cascasia*	Yellow-tail mullet	M, B
		Liza oligolepis	Large-scaled mullet	M, B
		Liza tade	Green-back mullet	M, B
	Schilbeidae	*Ailia coila*		F
		Ailiichthya punctata		F
	Amblycipitidae	*Amblyceps mangois*	Torrent catfish	F
Bata	Cyprinidae	*Cirrhinus reba*	Reba	F
		Labeo bata	Bata	F
Batashi	Schilbeidae	*Pseuttotropius atheronoides*		F
Bele	Gobiidae	*Glossogobius giuris*	Bar-eyed goby	M, F
Bhadi punti	Cyprinidae	*Puntius stigma*		F
Bhangan	Cyprinidae	*Labeo boga*		F
Bheda	Nandidae	*Nandus nandus*		F
Bhetki	Centropomidae	*Lates calcarifer*	Barramundi (or Giant seaperch)	F

Common Name	Family	Species	English Name	Habitat
Bhol	Cyprinidae	*Barilius bola*		F
Bishtara	Scatophagidae	*Scatophagus argus*	Spotted scad	M often B
Boal	Siluridae	*Wallago attu*	Freshwater shark	F
Bojori tengra	Bagariidae	*Mystus tengra*		F
Borguni	Theraponidae	*Therapon jarbua*	Crescent perch	M often B, F
Borong	Clupeidae	*Nematalosa nasus*	Long-ray bony bream	M
Chacunda	Clupeidae	*Anodontostoma chacunda*	Short-nose gizzard shad	M
Chalapunti	Cyprinidae	*Puntius chola*	Green barb	F
Chanda	Centropomidae	*Chanda nama*	Perchlet	F
Chandan ilish	Clupeidae	*Tenualosa hilsa*	Toli shad	M, F
Chapila	Clupeidae	*Gudusia chapra*		M
		Gonialosa manminna	Ganges gizzard shad	M
		Ilisha motius		M
Chatta chingree	Palaemonidae	*Macrobrachium malcolmsonii*	Monsoon river prawn	F, B
Chebli	Cyprinidae	*Danio aequipinnatus*	Giant danio	F
Checa	Chacidae	*Chaca chaca*	Squarehead catfis	F
Chela	Cyprinidae	*Oxygaster bacaila*		F
Chenua	Bagariidae	*Sisor rhabdophorus*		F
Chep chela	Cyprinidae	*Chela atpar*		F
		Chela laubuca	Winged rasbora	F
Chingree icha	Atyidae	*Caridina gracilirostris*	Needlenose caridina	F, B
		Caridina propinqua	Bengal caridina	F, B
	Palaemonidae	*Leandrites celebensis*		F, B
		Leptocarpus fluminicola	Ganges delta prawn	F, B
		Leptocarpus potamiscus	Bombay prawn	M, B
		Macrobrachium biramanicum	Birma river prawn	F, B
		Macrobrachium dayanum	Kaira river prawn	F
		Macrobrachium idae	Orana river prawn	F, B

Common Name	Family	Species	English Name	Habitat
		Macrobrachium kempi		F, B
		Macrobrachium lamarrei	Kuncho river prawn	F, B
		Macrobrachium lanchesteri	Riceland prawn	F, B
		Macrobrachium mirabile	Shortleg river prawn	F, B
		Macrobrachium palaemonoides		F, B
		Macrobrachium rude	Hairy river prawn	F, B
		Macrobrachium superbum		F, B
		Palaemon styliferus	Roshna prawn	M, B often F
		Palaemon modestus	Siberian prawn	F
		Palaemon karnafulianenis		F, B
		Palaemon serrifer spp.		F, B
		Palaemon semmelinkii spp.		F, B
		Palaemon olichodactylus	Goda river prawn	F
		Palaemon tenuipes	Spider prawn	M, B
Chiring	Gobiidae	*Apocryptes bato*		F
		Pseudapocryptes bato		F
Chitai	Notopteridae	*Notopterus chital*		F
		Notopterus notopterus		F
Choukka	Clupeidae	*Pellona ditchela*	Toothed shad	M
Chuna	Anabantidae	*Chuna chuna*		F
Chunobele	Gobiidae	*Gobiopterus chuno*		F
		Periophthalmodon schlosseri	Pug-headed mud skipper	F, B
		Periophthalmus barbarus		B
Chunobele	Taenioididae	*Taenioides cirratus*		M, B
Churi	Trichiuridae	*Trichiurus haumela*	Largehead hairtail	M
		Eupleurogrammus muticus	Smallhead hairtail	M
		Lepturacanthus savala	Savalai hairtail	M
Dahuk	Gobiidae	*Boleophthalmus boddarti*	Goggle-eyed goby	F
		Scartelaos viridis	Bearded goby	F
Darkina	Cyprinidae	*Esomus dauricus*		F

Common Name	Family	Species	English Name	Habitat
		Rasbora daniconius	Common rasbora	F
		Rasbora rasbora		F
Datina	Sparidae	*Acanthopagrus datnia*	Japanese silver bream	M
Dhal magur	Bagridae	*Glyptothorax botius*		F
		Glyptothorax telchitta		F
Dimua chingree	Palaemonidae	*Macrobrachium villosimanus*	Dimua river prawn	F
Dolichewa	Gobiidae	*Parapocryptes batoides*		F
Elang	Cyprinidae	*Rasbora elonga*		F
Gachua	Channidae	*Channa gachua*		F
Gang magur	Plotosidae	*Plotosus canius*	Striped catfish eel	M
Gang tengra	Bagariidae	*Gagata gagata*		F
		Gagata viridescens		F
		Gangra yussoufi		F
		Nangra nangra		F
Ghaura	Schilbeidae	*Clupisoma garua*		F
Ghonia	Cyprinidae	*Labeo gonius*		F
Ghor poa	Cyprinidae	*Garra annandalei*		F
		Garra gotyla		F
Ghora mach	Cyprinidae	*Labeo dyocheilus*		F
Ghorachela	Cyprinidae	*Oxygaster gora*		F
Gilipunti	Cyprinidae	*Puntius gelius*		F
Golda chingree	Palaemonidae	*Macrobrachium rosenbergii*	Giant river prawn	F , B sometimes M
Golsha	Bagariidae	*Mystus bleekeri*		F
Golsha tengra	Bagariidae	*Mystus cavasius*		F
Goti poa	Sciaenidae	*Otolithes maculatus*	Spotted croaker	M
Goti poa	Toxotidae	*Toxotes chatareus*	Spotted archerfish	F, B

Common Name	Family	Species	English Name	Habitat
Gozar	Channidae	*Channa marulius*		F
Guji	Bagridae	*Mystus aor*		F
Gura tengra	Bagridae	*Leiocassis rama*		F
Hail chanda	Stromateidae	*Parastromaeus niger*	Brown pomfret	M
Ilish	Clupeidae	*Hilsa ilisha*	Hilsa shad	M
Jarki	Gerreidae	*Gerres setifer*	Black-tipped silver biddy	B
Jarua	Cyprinidae	*Changunius chagunios*		F
Jaya		*Aspidaparia jaya*		F
Joya	Cyprinidae	*Barilius bendelisis* var *chedra*		F
Joyakhoksa	Cyprinidae	*Barilius bendelisis* var *cosca*		F
Kajuli	Schilbeidae	*Ailia coila*		F
		Ailiichthya punctata		F
Kala bata	Cyprinidae	*Crossochilus latius*		F
Kala datina	Sciaenidae	*Johnius diacanthus*	Two-spined croaker	M
Kalibaush	Cyprinidae	*Labeo calbasu*	Orange-fin labeo	F
Kanchanpunti	Cyprinidae	*Puntius conchonius*		F
Kanchki	Clupeidae	*Corica soborna*	Ganges river sprat	M, B
Kani pabda	Siluridae	*Ompok bimaculatus*	Butter catfish	F
Kani tengra	Bagridae	*Glyptothorax cavia*		F
		Laguvia ribeiroi		F
		Laguvia shawi		F
		Pseudecheneis sulcatus		F
Katla	Cyprinidae	*Catla catla*	Catla	F
Kete	Cyprinidae	*Osteochilus* spp.		F
		Rohtee cotio		F
Khaksa	Cyprinidae	*Barilius barna*		F
		Barilius shacra		F
		Barilius vagra		F

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Kholisha	Anabantidae	*Colisa fasciata*		F
Khorsula	Mugilidae	*Rhinomugil corsula*	Mullet	M
Koi	Anabantidae	*Anabas testudineus*	Climbing perch	F
		Macropodus cupanus	Palmyra-fibre fish	F
Koitor	Sciaenidae	*Johnius coibor*	Ganges croaker	M
Koli	Eleotridae	*Eleotris fusca*	Brown gudgeon	F, B
Kuli	Eleotridae	*Butis butis*	Flat-headed gudgeon	B
		Eleotris lutea		F, B
Kursha	Cyprinidae	*Labeo dero*		F
Kuta kanti	Bagariidae	*Conta conta*		F
		Erethistes pussilus		F
		Hara hara		F
		Hara jerdoni		F
Lakhua	Polynemidae	*Polynemus indicus*	Indian threadfin	M
Lalkhoilsa	Anabantidae	*Colisa lalia*		F
Magur	Clariidae	*Clarias batrachus*	Walking catfish	F
Mahashol	Cyprinidae	*Tor putitora*		F
		Tor tor	Mahsier	F
Meni	Nandidae	*Nandus nandus*		F
Mola	Cyprinidae	*Amblypharyngodon microlepis*		F
		Amblypharyngodon mola		F
Molapunti	Cyprinidae	*Puntius ambassis*		F
Morar	Cyprinidae	*Aspidaparia morar*		F
Mrigal	Cyprinidae	*Cirrhinus mrigala*	Mrigal	F
Muribacha	Schilbeidae	*Clupisoma garua*		F
Nandil	Cyprinidae	*Labeo nandina*		F
Neptani	Anabantidae	*Ctenops nobilis*		F
Nipati	Cyprinidae	*Danio donglia*		F

Common Name	Family	Species	English Name	Habitat
Nuna baila	Gobiidae	*Acentrogobius caninus*	Dog-toothed goby	M, B
		Acentrogobius cyanomos		M, B
		Acentrogobius puntang	Silver-spotted goby	M, B
		Acentrogobius viridipunctatus	Green-spotted goby	M, B
		Brachygobius nunus		M, F
		Oxyurichthys microlepis	Small-scaled goby	M
		Pogonogobius planifrons		M, F
		Stigmatogobius oligactis		M, F
		Stigmatogobius sadanundio		F, B
Nuna tengra	Bagariidae	*Mystus gulio*	Long-whiskers catfish	F
Pabda	Siluridae	*Ompok pabda*		F
Pangas	Pangasiidae	*Pangasius pangasius*		F
Pankal baim	Mastacembelidae	*Mastacembelus pancala*	Spiny eel	F
Parshe bata	Mugilidae	*Liza parsia*	Gold-spot mullet	M
Pathar chata	Cyprinidae	*Barilius tileo*		F
Pholi	Notopteridae	*Notopterus notopterus*		F
Pholichanda	Stromateidae	*Pampus argentus*	Silver pomfret	M
Phoolchela	Cyprinidae	*Oxygaster phulo*		F
Phopa chanda	Centropomidae	*Chanda daculis*		F
Phutanipunti	Cyprinidae	*Puntius phutunio*	Cuming's two-banded barb	F
Poa	Sciaenidae	*Pama pama*	Long-finned croaker	B
Punti	Cyprinidae	*Puntius puntio*		F
		Puntius titus		F
Raja chewa	Taenioididae	*Odontamblyopus rubicundus*		M, B
		Taenioides buchanani		M, B
Ranga chanda	Centropomidae	*Chanda ranga*		F
Rayeg	Cyprinidae	*Cirrhinus reba*		F
Rita	Bagariidae	*Rita rita*		F
Rui	Cyprinidae	*Labeo rohita*	Rohu	F

Common Name	Family	Species	English Name	Habitat
Rupchanda	Stromateidae	*Pampus chinensis*	Chinese pomfret	M
Shada chewa	Taenioididae	*Trypauchen vagina*	Burrowing goby	M
Shilong	Schilbeidae	*Silonia silondia*		F
Shing	Heteropneustidae	*Heteropneustes fossilis*	Stinging catfish	F, B
Shol	Channidae	*Channa striatus*		M
Shorpunti	Cyprinodae	*Puntius sarana*		F
Sinia	Bagariidae	*Gagata cenia*		F
Tailla	Polynemidae	*Eleutheronema tetradactylum*	Four-finger threadfin	M
Tak chanda	Gerreidae	*Gerres filamentosus*	Whipfin silver biddy	M
	Leiognathidae	*Leiognathus equulus*	Greater ponyfish	M
		Secutor insidiator	Slender-barred ponyfish	M
		Secutor ruconius	Deep-bodied ponyfish	M
Taki	Channidae	*Channa punctatus*		M
Tara baim	Mastacembelidae	*Macrognathus aculeatus*	Lesser spiny eel	M
Tengra	Bagridae	*Batasio tengra*		F
		Mystus vittatus	Striped dwarf catfish	F
Tiashol	Channidae	*Channa barca*		F
Titpunti	Cyprinidae	*Puntius ticto*	Fire-fin barb	F
Topshi	Polynemidae	*Polynemus sexfilis*	Golden sixthread tesselfish	M
		Polynemus paradiseus	Paradise threadfish	M

a) Adapted by V. Sambilay, Jr. and M. Ahmed (ICLARM), with corrections and addition of English common names and of habitat definition (M = marine, B = brackish and F = freshwater) from: Rahman, A.K. 1974. A checklist of the freshwater bony fishes of Bangladesh. Fisheries Research Station Bull. 1, Chandpur, Bangladesh and Kibria, G. and K. M. Ahmad. 1983. Prawn fisheries in Bangladesh. National Symposium on Agricultural Research, Bangladesh Agricultural Council, Bangladesh.