



EFFECTS OF SMALL SCALE SALINE WATER DEVELOPMENT SUBPROJECTS ON FISHERIES IN KHULNA DISTRICT, BANGLADESH

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Abstract: Small Scale Water Resources Development Sector Project (SSWRDSP), with the aim of flood control, drainage and irrigation has been introduced during 1996-2002 in Bangladesh by the Local Government Engineering Department (LGED) of ministry of local government and rural development. This study was undertaken for assessing the impacts of saline water subprojects on fisheries production. The study was carried out in two saline water subprojects in Khulna district based on primary and secondary data. The primary data was taken through Focus Group Discussion. Different indicators viz. fisheries area, fish species, fish production and fishers were used to evaluate the impacts of the subprojects on fisheries development. The year 1999 has been considered as the pre-project and 2004 as the post-project study period. Both the diversity and production of open water capture fishery have been decreased in the subprojects area. Different fish species have become rare in all the subprojects. However, the culture fishery has increased due to implementation of the project. The capture fishery in the Bagachra-Badurgacha Flood Control and Drainage (FCD) subproject area has totally been lost but the production of culture fishery has increased by 13%. In Narayankhali FCD subproject the production of capture fishery has been decreased by 87.8% while the production of culture fishery has increased by 7.10%. The number of fish farmers has increased but the number of fishers has declined in all the subproject areas. Some suggestions regarding the development of culture fishery and protection of capture fishery have been suggested.

Key words: Fish biodiversity, capture fishery, aquaculture, saline water, water development project, Bangladesh

Introduction

The Fisheries is one of the major economic activities of Bangladesh and is strongly associated with target groups, poverty alleviation and employment generation. The fisheries sub-sector is reported to account for about 3% of total gross domestic product (GDP), 8% of total export earnings, 10% of agricultural GDP, 60% of animal protein intake and 7% of total protein intake. It provides employment of about 2 million fulltime and 12 million part-time fishermen every year (Anon, 1999a). The inland fisheries resource of Bangladesh is considered as one of the diverse fisheries in the world. Bangladesh has about 4,345,936 ha inland water bodies in the form of rivers, canals, beels, jheels, haors, baors, ponds, ditches, and lakes (Anon, 2002b). About 260 species of freshwater fish belonging to 55 families, 25 types of tortoises and turtles and 56 species

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of palaemonid and penaeid prawns live in the wetlands of Bangladesh (Ali, 1991). Inland fisheries and aquaculture are the major contributors of fish production covering 50% and 22% of the total production respectively (Anon, 2002b). However, over the years fish production from inland open waters has been declined from 69.13% in 1992-93 to 46.67% in 2001-02 (Anon, 2002b). It is assumed that different types of native fish species are declining day by day due to the construction of different water control structures under water development projects.

During 1975-76 the effect of Chandpur, Muhuri and Karnafuli FCD Projects on fisheries was evaluated (Anon, 1995). Latter, the Master Plan Organization (MPO) reviewed the impact of flood control, drainage and irrigation projects on fisheries (Anon, 1995). The National Water Policy (Anon, 1999b) has emphasized that water development projects should not interrupt fish movement. LGED has developed 280 subprojects under SSWRDSP including 91 with fisheries components in the western part of Bangladesh. The external evaluation report of the first phase of SSWRDSP (Anon, 2003) highlighted the need for finding out the effects of projects on fisheries in details. Under this context a study was undertaken to evaluate the performances of two of the 91 SSWRDSP in terms of change in species diversity and production of fish before and after the implementation of the projects. Indicators for evaluating the performance of SSWRDSP on fisheries have also been included.

Materials and Methods

In order to understand how irrigational facilities of the SSWRDSP affect fisheries, two saline water subprojects with fisheries components in Khulna district have been selected as the study area. Among two, the Bagachra-Badurgacha FCD subproject in Dumuria *upazila* has positive impacts on fisheries while Narayankhali FCD subproject in Batiaghata *upazila* has negative impacts on fisheries (Anon, 2002a). The study was carried out on the basis of both primary and secondary data. Primary data on post-project were collected from field survey through Focus Group Discussion during October 2004 to April 2005. While the data on pre-project were collected from both appraisal reports of the projects and field survey. The Focus Group comprised of Chairman/ members of the Water Management Co-operative Association (WMCA), fish farmers, fishermen, manager/s of the fish farming water area, rice farmers, etc. The secondary data were collected from the appraisal reports of the projects and these were cross-checked during field survey. Data on people considered to be beneficiaries of the projects were collected from the respective *Union parishad* offices. Other important secondary information was collected from different published and unpublished reports/ journals from the LGED of Dhaka, and Khulna, DoF, WARPO, BUET, Khulna university and other government and non-government organizations. The year 1999 was considered as the pre project study year because it was the last year before implementation of the projects, and the year of 2004 was considered as the post project study year. After collecting primary and secondary data compilation, analysis, and comparison (as necessary) were done to meet the study objectives. Different indicators have been developed to evaluate the performance of the projects. Similar indicators have been suggested by International Water Management Institute (IWMI) for the evaluation of the impact of irrigation projects on agriculture (Bos *et al.*, 1994). A negative value of any of the suggested indicators was considered as negative impact on fisheries whereas a positive value was considered as positive impact. The higher the value the higher the impact and the *vice versa*.

Results

Effects of SSWRDSP on fish biodiversity: The Bagachra-Badurgacha FCD subproject was a saline water subproject, suitable for shrimp farming. The composition of the fish species (pre and post project), and their contribution to the total catch are presented in Tables 1, 3 and 4. The *Scatophagus argus* (Paira) fish has become rare; *Oreochromis mossambicus* (Tilapia) and *Lates calcarifer* (Vetki) that were farmed previously, have greatly diminished in number. The

Table 1. Capture and culture fish composition during pre (1999) and post-project (2004) period in Bagachra-Badurgacha FCD subproject.

Project status	Water area (ha)		Fish types and Fish species available in the project area	
	Capture	Culture	Capture	Culture
Pre-project	20	300	Shrimp: Other Small shrimp (Chingri), Bagda ^b Cat fish: <i>Mystus tengra</i> (Tengra) White fish: Vetki, <i>Mugil cephalus</i> (Parsha), Paira	Shrimp: Bagda, Galda, (chingri) ^a Tilapia: Tilapia Cat fish: Tengra ^a White fish: (Vetki, Parsha, Paira) ^a
Post-project	--	300	--	Shrimp: Bagda, Galda, Chingri ^a Tilapia: Tilapia ^a Cat fish: Tengra ^a White fish: (Vetki, Parsha) ^a

a = Fish species which are not cultivated but found in the cultivated area; b = not capture fish but found in the area of capture fisheries.

Table 2. Capture and culture fish composition during pre (1999) and post-project (2004) period in Narayankhali FCD subproject.

Project status	Water area (ha)		Fish types and Fish species available in the project area	
	Capture	Culture	Capture	Culture
Pre-project	300	150	Shrimp: Chingri Small indigenous fish: Phasa, <i>Puntius punctius</i> (puti) Cat fish: Shing, Magur, Tengra Air breathing Fish: <i>Channa punctatus</i> (Taki), <i>Channa striatus</i> (Shoal), <i>Anabas testidunius</i> (Koi) Carp fish: (Rui, Catla) ^b	Shrimp: Bagda, Galda, Chingri ^a Tilapia: Tilapia Cat fish: Tengra ^a White fish: (Vetki, Parsha) ^a
Post-project	50	200	Shrimp: Chingri Small indigenous fish: puti Cat fish: <i>Heteropneustes fossilis</i> (Shing), <i>Clarius batrachus</i> (Magur), Tengra Air breathing Fish: Taki, Shoal, Koi Carp fish: <i>Labeo rohita</i> (Rui) ^b	Shrimp: Bagda, Galda, Chingri ^a Cat fish: African magur*, Tengra ^a Tilapia: Tilapia ^a White fish: (Vetki, Parsha) ^a

a = Fish species which are not cultivated but found in the cultivated area; b = not capture fish but found in the area of capture fisheries; * = Cultured in about 10 ha land

contribution of the shrimp especially *Penaeus monodon* (Bagda) to the total production has increased by 30% during the study period of 1999 to 2004. The contribution of cat fish and other non-shrimp species (white fish) have decreased significantly. Narayankhali FCD subproject with its large flood plain and vast network of canal was rich in capture fisheries but in the recent years many species of capture fisheries have either been lost or become rare. Tables 2, 5 and 6 represent the pre- and post-project situation of fish species and their contribution to total production. The *Setipinna phasa* (Phasa) and *Catla catla* (Catla) fishes have become rare in the subproject area, and the Air breathing fish, carps and small indigenous fishes have decreased significantly. It was interesting to observe that hybrid exotic cat fish, *Clarius geripinus* (African magur) was introduced as farmable species in a few hectares of land in the study area.

Fish production: Although the fish production from capture fishery has decreased but the culture fishery has increased in most cases in the project areas. In the Bagachra-Badurgacha subproject area shrimp production was found to increase due to the implementation of the subproject. Though an area of 20 ha capture fisheries with a production of 3.28 MT fish in 1999 has been lost due to the project, the higher return from shrimp farming has been able to replace it. Tables 7 and 8 show the yields and total production of different types of fishes. Therefore, total fish production

Table 3. Contribution of capture fishery to the total fish production in Bagachra-Badurgacha FCD subproject area.

Fish types	% Contribution to the total production	
	Pre-project	Post-project
Shrimp	1	--
Cat fish	0.60	--
White fish	2.10	--
Subtotal	3.70	--

(capture+culture) of Bagachra-Badurgacha FCD subproject area has increased by 8.9% during the 1999-2004 periods.

The post project average yield (capture+culture) has also increased by 16.1% (considering the pre project production from capture fisheries), while the culture fish production has increased by 13.1% during the same period. The yields of *Bagda* and *Macrobrachium rosenbergii (Galda)* had increased by 85% (85 kg ha⁻¹) and 300% (30 kg ha⁻¹) respectively. The yield of *Tilapia* has decreased from 42 kg ha⁻¹ to 20 kg ha⁻¹. Similarly the yield of *Vetki* fish has decreased. Tables 9 and 10 represent the production (pre and post project) of capture and culture fisheries in Narayankhali FCD subproject area. The total fish production (capture+culture) and production from capture fishery of Narayankhali FCD subproject were decreased by 40.1% and 87.8% respectively during 1999-2004 periods. Production from culture fishery was increased by 7.1%, which was mainly contributed by the cultivation of *African magur* with an yield of 300 kg ha⁻¹ (higher than any other fish species). The yield of *Bagda* was decreased slightly (11.11%) while the yield of *Galda* was increased by 33.33%.

Table 4. Contribution of culture fishery to the total pre and post-project fish production in Bagachra-Badurgacha FCD subproject.

Fish types	% Contribution to the total production	
	Pre-project	Post-project
Shrimp	44.90	75.90
Tilapia	14.30	6.30
Cat fish	7.50	4.10
White fish	29.60	13.70
Subtotal	96.30	--
Total	100	100

Table 5. Contribution of capture fishery to the total pre and post-project fish production in Narayankhali FCD subproject.

Fish types	% Contribution to the total production	
	Pre-project	Post-project
Shrimp	5.30	1.10
SIF	8.50	1.70
Cat fish	14.10	2.60
ABF	12.90	3.40
Carp fish	8.90	1.40
Subtotal	49.70	10.20

SIF = Small indigenous fish; ABF = Air breathing fish

Table 6. Contribution of culture fishery to the total fish production in Narayankhali FCD subproject.

Fish types	% Contribution to the total production	
	Pre-project	Post-project
Shrimp	26.30	53.90
Tilapia	8.10	13.50
Cat fish	2.80	7.20
White fish	13.10	15.30
Subtotal	50.30	89.90
Total	100	100

Table 7. Pre and post-project capture fish yields of Bagachra-Badurgacha FCD Subproject.

Fish types	Yield (kg ha ⁻¹)		Production (MT yr ⁻¹)	
	Pre-project	Post-project	Pre-project	Post-project
Shrimp	45	--	0.90	--
Cat fish	27	--	0.54	--
White fish	92	--	1.84	--
Total	164	--	3.28	--

Impacts of the subprojects on fishermen and fish farmers: The pre-project and post-project number of fulltime and part-time fishermen and fish farmers of Bagachra-Badurgacha FCD subproject area are presented in Fig. 1. The number of fish farmers was increased by 94.44% during the study period. There were no fulltime fishermen however, considerable number of part-time fishers were decreasing over time (decreased by 50%). Most of the part-time fishermen were found to be engaged in harvesting fish from commercial shrimp farm (ghers) as laborers. While in Narayankhali FCD subproject area the number of fish farmers increased by 42.86% during the same period. However, fish farmers were facing challenges of low yields of shrimp due to viral outbreak. The number of both part-time and full time fishermen was decreased greatly in this area. The pre and post project number of part-time and fulltime fishermen and fish farmers in Narayankhali FCD subproject area is presented in Fig. 2.

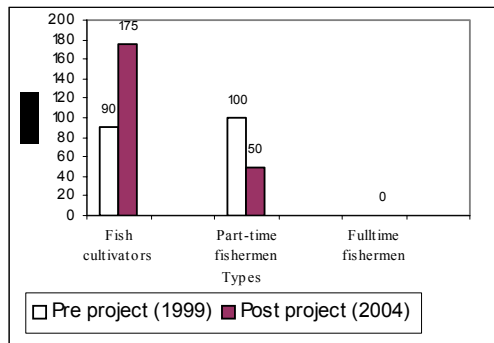


Fig. 1. Number of pre and post project fishermen and fish cultivators of Bagachra-Badurgacha FCD subproject.

Table 8. Pre and post-project culture fish yields of Bagachra-Badurgacha FCD Subproject.

Fish types	Yield (kg ha ⁻¹)		Total production (MT yr ⁻¹)	
	Pre-project	Post-project	Pre-project	Post-project
Shrimp:			39.6	72.90
<i>Bagda</i>	100	185		
<i>Galda</i>	10	40		
<i>Small chingri</i>	22	18		
Tilapia	42	20	12.6	6
Cat fish	22	13	6.60	3.90
White fish	87	44	26.1	13.20
Total	283	320	84.9	96

Evaluation of performance indicators in the development of fisheries: The indicators of performance of fisheries development in the study area used are summarized in Table 11. It is evident from the table that in all the projects there has been a complete or nearly complete eradication of capture fishery. A few numbers of fish species has been declined in the project areas over the five year period. Although the production in culture fishery was increased steadily but total fish production exhibited variable results. In Bagachra-Badurgacha FCD subprojects area there was some increase in the total production but in Narayankhali FCD subproject area the total production was declined. The number of fishers was decreased by 29% to 43% in the subprojects area.

Discussion

In Bagachra-Badurgacha FCD subproject area fish species like *Paira* has become rare due to construction of embankment along the rivers to protect shrimp *ghers*. Shrimp *gher* owners are trying to diminish the *Tilapia* and *Vetki* from their *ghers* as they eat shrimp fries as food. The production of *Bagda* and *Galda* has increased in Bagachra-Badurgacha FCD subproject area due

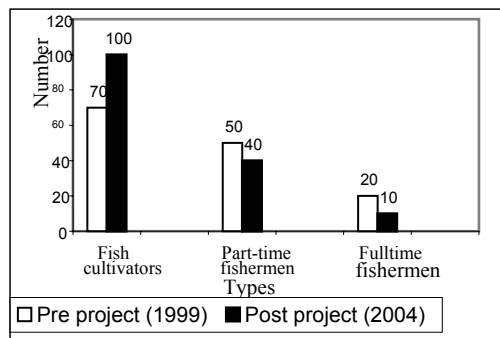


Fig. 2. Number of pre and post project fishermen and fish cultivators of Narayankhali FCD subproject.

Table 9. Pre and post-project capture fish yields of Narayankhali FCD Subproject.

Fish type	Yield (kg ha ⁻¹)		Production (MT yr ⁻¹)	
	Pre-project	Post-project	Pre-project	Post-project
Shrimp	13	10	3.90	0.50
SIF	21	15	6.30	0.75
Cat fish	35	23	10.50	1.15
ABF	32	30	9.60	1.50
Carps	22	12	6.60	0.60
Total	123	90	36.90	4.50

SIF = Small indigenous fish; ABF = Air breathing fish

Table 10. Pre and post-project culture fish yields of Narayankhali FCD Subproject.

Fish types	Yield (kg ha ⁻¹)		Total production (MT yr ⁻¹)	
	Pre-project	Post-project	Pre-project	Post-project
Shrimp:			19.50	24
<i>Bagda</i>	90	80		
<i>Galda</i>	15	20		
<i>Small chingri</i>	25	20		
Tilapia	40	16	6	3.20
Cat fish	14	30+15	2.10	6
White fish	65	34	9.75	6.80
Total	249	185*	37.35	40

* = Except *African magur*

to high investment and better care by the fish farmers; arrangement of training workshops by the LGED as well as encouragement of the local people to shrimp farming by the socio-economist of Khulna LGED. As the fish farmers can easily get and/or drain saline water through the newly constructed sluices, the number of fish farmers is increasing day by day.

Table 11. The indicators of performance of fisheries development in the subproject areas.

Indicators	Subprojects	
	Bagachra-Badurgacha	Narayankhali
% change in area of capture fishery	-100	-83.3
% change in area of culture fishery	00	+33.3
change in total number of species	-1	-1
% change in species (capture)	NA	-18.2
% change in species (culture)	-12.5	+14.3
% change in production (capture)	-100	-87.8
% change in production (culture)	+13.1	+7.1
% change in total production	+8.9	-40.1
% Change in fishermen (part-time+fulltime)	-50	-28.6

* = % changes in species during post project (ignoring capture or culture)

As there were limited opportunities for capture fisheries during pre-project condition and no capture fisheries exist during post project, so there is no fulltime fishermen. The same reason is responsible for decreasing the number of part-time fishermen as they have no free access to the open water fisheries and have to work as a labour in the shrimp *ghers*.

Due to the construction of the embankment and five sluice gates in Narayankhali FCD subproject, the river flood is now controlled that caused in the loss of many open water species. Another reason that has made many capture fish species to become rare was the introduction of extensive saline water through the canals (for shrimp farming) that was previously flooded by the fresh water during rainy season and played a vital role in capture fisheries.

The total fish (capture+culture) production of Narayankhali FCD subproject has decreased due to the reduction of the most of the flood plain fish habitats. The yield of *Bagda* has decreased slightly due to the water pollution from fish processing industries and less interest by the fish farmers as many of them is involved in other business in nearby Khulna city. However, the yield of *Galda* has increased as it can adapt in polluted water. In spite of this, the total production has increased slightly due to farming of *African magur* with high yield rate (300 kg ha⁻¹). Due to loss of capture fishery as well as shrimp farming the fishermen are looking for alternative works. These reasons have decreased both the part time and full time fishermen in Narayankhali FCD subproject area. At the initial stage of the project, the number of fish farmers was increased; however as the fish farmers faced challenges of low yields of shrimp the number of fish farmers fell down at the minimum at post-project time. It is remarkable to note that the shift from capture to culture fishery has resulted in an increase in production of culture fishery but its impact on the subprojects' total production has become varied.

The eradication of capture fishery has become the main reason for the declination of fishers, which not only mean the change in livelihood of the fishers but also resulted in poor availability of fish protein for their families. Thus it can be summarized that one of the two subprojects studied had positive impacts on total fish production, but considering the decrease in capture fishery, loss in species diversity and decrease in number of fishers in all the sub-projects the negative impacts outweigh the positive impacts of SSWRDSP.

Recommendations

The following measures have been recommended for further development of fisheries in the SSWRDSP:

- 1) in any subprojects with fisheries components, sub groups of fishermen should be formed under WMCA so that their interests and aspirations are adequately addressed.
- 2) In projects where loss of capture fisheries are anticipated, adequate rehabilitation measures of the fishers should be planned by providing them with loan, training and access to government land (*Khans*) for adopting culture fishery.
- 3) Effective and periodic monitoring and evaluation of the projects with fisheries components by LGED and local NGOs in association with competent fisheries authority is necessary to mitigate the loss of capture fisheries through culture fisheries.

Conclusion

Capture fishery that plays an important role in alleviating nutritional deficiencies of the rural poor was depleting rapidly due to the implementation of SSWRDSP. However, the culture fisheries have expanded in all the subproject areas as the flood and required water depth for fish farming are controlled. The area, yield and production of capture fisheries in all the subprojects have substantially reduced due to the implementation of the SSWRDSP. In each subproject some open water fish species have become rare mainly due to the reduction of flood plain fish habitats although the production of culture fisheries has increased in all the subprojects. The number of fish farmers has increased in the subprojects studied but the number of part-time and fulltime fishermen has declined significantly due to restriction in free access to the open water capture fishery, and loss of open water flood plain fish habitat. As the study was conducted on only 2 of the 91 subprojects, further study on rest of the subprojects is necessary to establish the findings of this study.

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