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## SOCIOECONOMIC CONSTRAINTS OF A TROPICAL OXBOW LAKE ECOSYSTEM IN GANGA RIVER BASIN AND STRATEGIES FOR SUSTAINABLE MANAGEMENT

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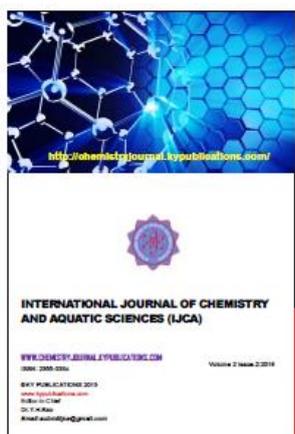
RESEARCH ARTICLE

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### ABSTRACT

Present research was conducted to assess the potential socioeconomic constraints of a semi-closed tropical oxbow lake ecosystem in Nadia district of West Bengal, India and also to propose strategies for its sustainable management during April 2011-November, 2014 through survey and analysis using continuum scale. Various social and economic information on problems and constraints on priority basis were found with varied dimensions. The potential constraints of cooperative management of the society based on oxbow lake ecosystem were also identified. Different sustainable management strategies were suggested against various potential constraints.

Key words: socioeconomic monitoring, oxbow lake ecosystem, anthropogenic impact



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### INTRODUCTION

Fishers are among the poorest sections of the society living in different aquatic ecosystems. Various authors have tried to assess their living standards in different aquatic ecosystem. The standard of living of fishermen has been reported to be very low (Zahan, 2013). About 74% fishers were found living in *Kancha* house (Abdullah-Bin-Farid *et al.*, 2013). About 71 % of fishers were found to have landholding below 0.5 ha (Baruah *et al.* 2000). They are among the most weaker and vulnerable sections of the society living with minimum standard of life. The majority (54%) fishers were reported to be illiterate but they could only sign (Kostori, 2012) and most of fishers (66.6%) were also found with incomplete primary and junior education (Peixer and Petreire, 2009). Changed climate and declining fish stock among many other important factors may influence fishing profession. About 56% of fisher population was reported to be involved in fishing, 72% in selling labour during off fishing period (Kostori, 2012). Fishers were also observed to be 52-79% professional, 5-29% seasonal and 14-31% subsistence fishers (Ahmed *et al.*, 2005). However, People were found to be more interested in agriculture, fishing than other occupations (Biswasroy *et al.*, 2011; Roy *et al.*, 2012).

Fishers face many constraints in their personal, social, cultural, economical, marketing, technical, ecological, professional, managerial arena. Varied authors reported different constraints based on importance of fishers on oxbow lake ecosystems (Bhaumik *et al.*, 1991; Annamalai, 1996; Upare, 1996; Bhaumik, 1997; Choudhary *et al.*, 2001; Makombe and Sampath, 2003; Nair *et al.*, 2007; Datta and Kundu, 2007; Sau *et al.*, 2012). But it might not be possible to achieve equitable and sustainable socioeconomic development for the people of the Gangetic basin in West Bengal without improving the sustainability of the ecosystem through responsible utilization of water resources by the people (Bhaumik *et al.*, 2006) and the public awareness is thus compulsory to conserve wetland biodiversity (Thompson, 1996).

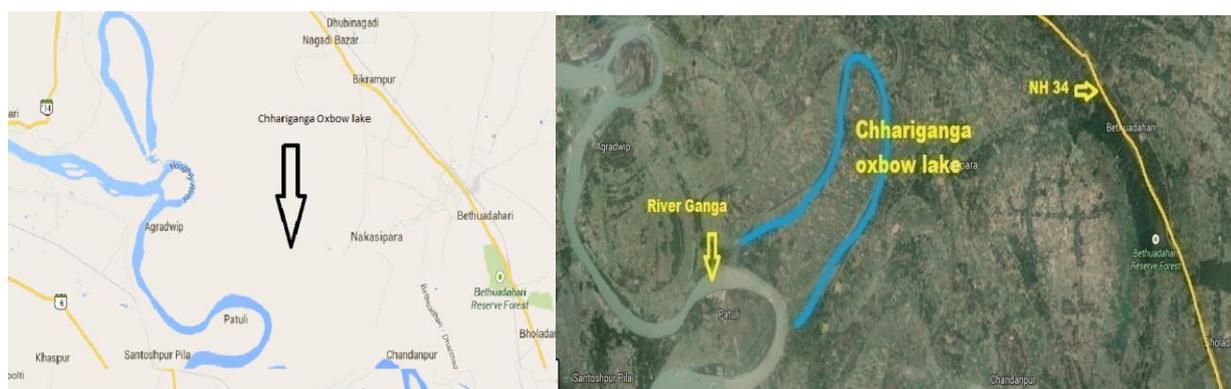
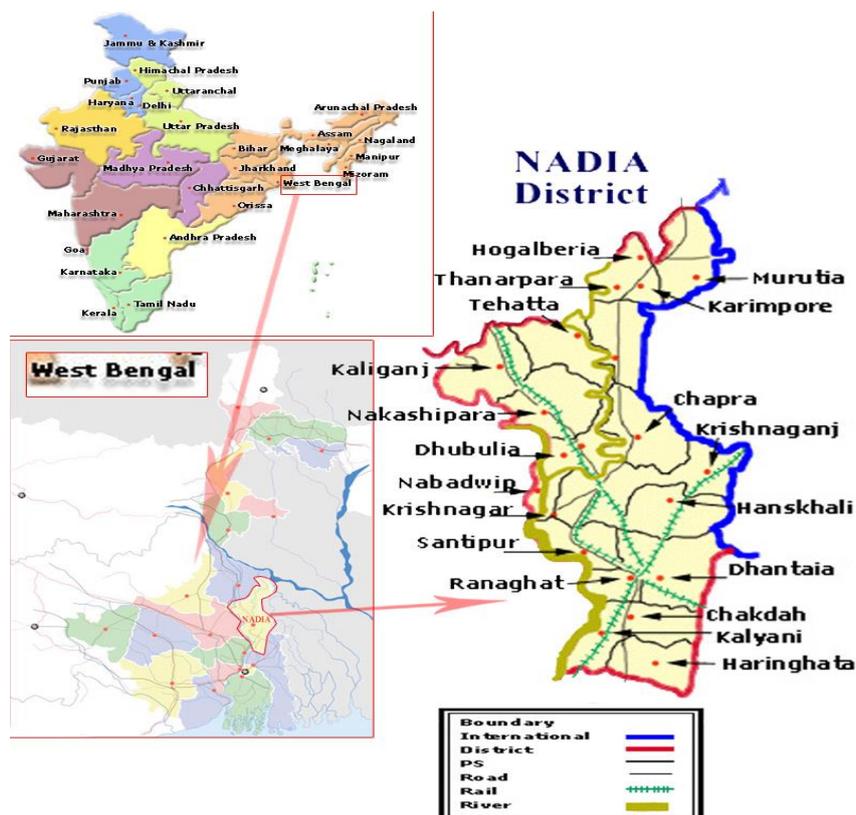
However, the works on the socioeconomic surveys of tropical oxbow lake ecosystem in Ganga river basin for sustainable management are scanty and the present research was thus conducted to assess the potential

socioeconomic constraints of a tropical oxbow lake ecosystem in Nadia district of West Bengal, India and propose strategies for its sustainable management.

**MATERIALS AND METHODS**

**STUDY AREA**

The Chhariganga oxbow lake, abandoned, fractioned and derived from the river Ganga is located in Nakashipara development block of Nadia district, West Bengal, India. It is situated at 23.5800°N, 88.3500°E, about 90 Km away from Kalyani university campus, Nadia and nearly 40 km away from the line of tropic of cancer towards the north. It is fresh water and semi-closed type oxbow lake and receives water from the river Ganga during monsoon through a narrow channel at the north east corner of a loop of the river. The oxbow lake is spread over an area of 145.69 acres with an annual average depth of 8.5 ft. It also stores rain water. The catchment area of the oxbow lake is nearly 600 hectare (Figure 1).



**Figure 1. Map showing study area**

There are three distinct annual seasons observed in changed climate of this region: the monsoon or rainy season generally from July to October when jute retting period lies normally during August- September, postmonsoon or winter from November to February and the premonsoon or dry season from March to June. There was an occasional inundation of the surrounding banks during the monsoon. The oxbow lake is subjected to all forms of human activities

including jute retting during monsoon, agriculture and fishing. It is the only source of irrigation water to the immediate agriculture communities.

### Socioeconomic Survey and analysis

A qualitative research approach (Nelson, 1991) supplemented by quantitative data analysis was followed in this study. Several participatory rural appraisal (PRA) tools (Chambers, 1994; Pretty *et al.*, 1995; Grenier, 1998; Angrosino, 2002; Morgan *et al.*, 2008) such as interviews with semi-structured questionnaires, personal interviews, focus group discussions and mini workshops were used in the present study. Serious efforts were made to involve and have close contact with fishers involved directly and indirectly with the Kutirpara Primary Fishermen's Cooperative Society Limited (KPFCS) based on the Chhariganga oxbow lake ecosystem. As many as 25 key informant interviews were carried out with a semi-structured questionnaire and obtained their in-depth ideas, solutions, and overall opinions regarding sensitive topics and problems associated with the fishing operation, KPFCS and Chhariganga oxbow lake ecosystem operations, sustainability, and organizational capability. A case study portrays the reality of a fisheries cooperative society and fishers' society which is now lacking in the region. Five mini-workshops were arranged with the help of KPFCS to verify data and disseminate research findings to the fishers' community. Several books, libraries, reports, and the internet were used as a source of secondary data.

Data were collected from randomly selected 25 fishers (about 10% of the KPFCS members) by personal interview (PI) with a well-structured questionnaire. Participatory rural appraisal (PRA) tool such as focus group discussion (FGD) was conducted with the fishermen to get an overview of the management system of the Chhariganga oxbow lake and their socio-economic condition. Nearly 80% of the fishermen (**Table 1**) who attended the PI and FGDs belonged to the age of more than 50 years who have been observing the oxbow lake with their matured eyes for at least 30 years. The FGDs were conducted with a pre-structured and pre-tested questionnaire involving fishers of the Kutirpara primary fishermen cooperative society limited based on the Chhariganga oxbow lake of our interest. After collecting the data from the fishermen cross-check interviews were conducted with key persons such as, Assistant Director of Fisheries, Nadia and the relevant stake holders for confirmation of the information.

**Table 1. Age group of fishers attended PI and FGDs**

Age group	40-50	50-60	60-70
%	20	08	72

All the collected data were summarized and scrutinized carefully and analyzed by MS Excel and then presented in textual, tabular and graphical forms to understand the management system of the oxbow lake fishery and the socioeconomic conditions of the fishermen in the study area. The different possible constraints which may be faced by the fishermen cooperative societies were enlisted in pre-designed schedule to measure the intensity of constraints. There were five broad areas of problems i.e. social, economic, technical, marketing and general constraints included for the purpose. Each constraint area was further divided into different specific aspects as required. To measure the intensity of constraints faced by oxbow lake, a three point continuum scale is used. These three points are most important, important and least important, which were scored 2, 1, 0, respectively. The mean score is calculated for individual constraint separately and is ranked accordingly (**Table 2**).

**Table 2. Three point continuum scale**

Points	Scores	Mean scores	Rank
Most important	2		1
Important	1		2
Least important	0		3

## RESULTS

### Social information of the fishers' community

Total 1240 members involving 270 fisher families and fisher members were found in the Kutirpara Primary Fishermen Cooperative Society Limited based on Chhariganga Oxbow Lake. On educational level, 50.16% of the fishers members was found to have completed primary education, 16.61% secondary education, 14.68% capable of only putting signature, 17.42% illiterate. The community constraints in household survey through PRA and PI (**Table 3**) revealed that fisher family faced community constraints of lack of fishery law enforcement ranked as the 1<sup>st</sup>, No control

over/management of water resources was pointed out as 2<sup>nd</sup> topmost constraint. Proper initiative from government or community to improve water resource was lacking that was their stumbling block to improvement and ranked as the 3<sup>rd</sup> constraint among many others.

**Table 3. Community constraints in household survey through PRA and PI**

Constraints	Fishers numbers	family %	Constraints Ranking
a. Lack of fishery law enforcement	99	36.67	1
b. No control over/management of water resources	73	27.04	2
c. No proper initiative from government or community to improve water resource	62	22.96	3
d. Lack of knowledge	12	4.44	4
e. Lack of united effort	9	3.33	5
f. Lack of information	8	2.96	6
g. Lack of awareness	7	2.59	7
<b>Total</b>	<b>270</b>	<b>100.00</b>	

The analysis of priority ranked problems faced by fishers' community with effects and possible solutions was surveyed through PRA (**Table 4**). Siltation and lake water choked with weed effecting reduced water and fishing hindrance, jute retting in the oxbow lake impacting water pollutions and reduction/extinction of fishes and encroachment of vested land by farmers and water lifting causing reduced lake water (area) were the important problems on priority basis out of total 17 problems of different dimensions.

**Table 4. Analysis of priority problems faced by fisher's community through PRA**

Ranking	Problems faced	Effects/impacts	Solutions as proposed by the fishers community
01	Siltation and lake water choked with weed	Reduced effective water area surface and fishing hindrance	Government job scheme to re-excavation and clear
02	Jute retting in the oxbow lake	Water pollution, fish disease and high fish mortality, skin disease and other health problem, water pollutions and reduction/extinction of fishes	Government to intervene and promote alternative retting techniques, training on alternate and modern jute retting techniques, government policy against jute retting
03	Encroachment of vested land by farmers and water lifting	Reduced lake water (area)	Government to demarcate lake boundary and ban or regulate water lifting
04	Bad road communication	Bad communication	Government to make all weather road
05	Natural fish declining	Reduced biodiversity and income/livelihood, negative impact on poor fishers	Stop catching brood fish, conservation of wild fish, sanctuary establishment, ban harmful gears, proper implementation of fishery law, breed and rehabilitate extinct/rare species, awareness building
06	Water pollution and use of pesticides	Water pollution, fish disease and fish mortality, reduced biodiversity, deteriorated aquatic	Provide training on IPM, composting, control use of pesticides, promote alternative jute retting techniques

Ranking	Problems faced	Effects/impacts	Solutions as proposed by the fishers community
		health and increased disease	
07	Lack of educational institutions	Low education level among fishers	Government to build educational institutions, awareness about need of education
08	Lack of safe drinking water	High water borne disease, poor health and savings	Government to build arsenic free, safe water tube wells
09	Lack of healthcare facility	Fishers travel long distance for getting access to medical facilities	Government to build hospitals
10	High cost of cultivation	Reduced profit	Government to provide subsidized quality inputs
11	Scarcity of fishing crafts and gears	Reduced individual income from fishing	Government to supply
12	Low prices of agricultural commodity	Loss of profit and savings	Government to purchase at minimum support price (MSP)
13	Catching brood fish during breeding period	Low fish recruitment and production	Government to make non fishers and non members also observe close season, seasonal pension scheme for life support for members
14	Conflict and poaching by nonmembers and non-fishers	Reduced fish catch, very low fish population, low income	Government to intervene by imposing local rules including temporary ban period
15	Fish disease	Loss of production and profit	Fish insurance scheme to cover the loss
16	Electricity	Poor education and development	Government to ensure electricity for all
17	Lack of sanitation	Poor health and savings	Government to help setting toilets

#### Economical information of the fishers' community

Land ownership of the household (Table 5) through PRA revealed that 37.04% of the fishers community members are small holders having farm land (0.03 - 0.13 ha), 33.33% as functionally landless (having only house land), 22.22% as landless but possessing farm land on lease, and remaining 7.41% as medium holders having own land (0.50 - 1.00 ha). Out of total 1240 family members surveyed, about 49.76% are student, 10.0% are children not yet in school 10.32% are house wives while 6.85% as agricultural labourers, 3.39% cultivate in own land, 2.58% are fishers in primary profession and 5.65% in secondary profession, 2.26% as fish traders, 2.18% each as non agricultural labourers, carpenter/mason/blacksmith and government servants. Nearly 1.21% are with cultivation in own and sharecrop land, 1.13% rickshaw/van pullers, 0.16% as fish culturists, 0.08% are with livestock culture. Around 0.16% is with handicraft making as their secondary occupation, 0.81% is teachers in secondary profession (Table 6).

**Table 5. Land ownership pattern of the fishers households through PRA**

Category	KPFCS members Numbers	Fishers community %
1. Small holders having farm land (0.03 - 0.13 ha)	100	37.04
2. Functionally landless (having only house land)	90	33.33
3. Landless but possessing farm land on lease	60	22.22
4. Medium holders having own land (0.50 - 1.00 ha)	20	7.41

Category	KPFCS members Numbers	Fishers community %
5. Absolutely landless	-	-
6. Landlord	-	-
<b>Total</b>	270	100.00

Table 6. Categorization of occupation of all fishers' household members through PRA

Occupation	Number		Percentage	
	Primary	Secondary	Primary	Secondary
1. Agricultural labourer	85	-	6.85	-
2. Cultivation in own land	42	-	3.39	-
3. Fishing	32	70	2.58	5.65
4. Fish traders	28	-	2.26	-
5. Nonagricultural labourers	27	-	2.18	-
6. Carpenter/mason/blacksmith	27	-	2.18	-
7. Government service	27	-	2.18	-
8. Cultivation in own and sharecrop land	15	-	1.21	-
9. Rickshaw/van	14	-	1.13	-
10. Sharecropper only	10	-	0.81	-
11. Fish culture	2	-	0.16	-
12. Livestock	1	-	0.08	-
13. Poultry rearing	-	-	-	-
14. Handicraft	-	2	-	0.16
15. Petty trade	-	-	-	-
16. Teacher	-	10	-	0.81
17. Other employee/Non-government service	-	-	-	-
<b>Sub total</b>	310	82	25.00	6.61
18. Student	617	-	49.76	-
19. Housewife	128	-	10.32	-
20. Children not yet in school	124	-	10.00	-
21. No activity	61	-	4.92	-
<b>Total</b>	1240	82	100	6.61

Around 74.81% of women were associated with livestock rearing (e.g. goats, cattle, poultry), 17.04% sale milk, 4.44% do homestead gardening, 3.7% make handicrafts (Table 7) and 100% of fishers' families were found to be having houses of concrete/tin (expensive) roofs (Table 8).

Table 7. Involvement of women in different economic activities through PRA

Activity	Count	%
1. Livestock rearing (e.g. goats, cattle, poultry)	101	74.81
2. Milk sale	23	17.04
3. Homestead gardening	6	4.44
4. Handicrafts	5	3.70
5. Labouring (agricultural and other)	-	-
6. Collection of aquatic resources	-	-

7. Post-harvest work	-	-
8. Teacher	-	-
<b>Total Number</b>	135	100.00

**Table 8. Type of housing owned through PRA**

Type	Number	%
1. None	-	-
2. One thatched bed/storage room	-	-
3. Multiple room with thatch roof	-	-
4. One room with tin (cheap) roof	-	-
5. Multiple room with tin (cheap) roof	-	-
6. Concrete/tin (expensive) roof	270	100
<b>Total</b>	270	100

The household dependencies on fishing through PRA (**Table 9**) revealed that about 11.85% of the community depended exclusively for fishing for their livelihoods, 40% on part time basis meet their fish protein demand as well as to generate some additional income to family. But the majority (48.15%) did not depend on fishing. About 79.63% fishers' households run as usually food deficit, 10.37% as occasionally deficit, 8.89% as breakeven and only 1.11% making surplus (**Table 10**).

**Table 9. Household dependency on fishing through PRA**

Involvement in fishing	Number	%
a. Full time fishing	32	11.85
b. Fishing for food	-	-
c. Part time fishing for food and income	108	40.00
d. Other than fishing	130	48.15
<b>Total</b>	270	100.00

**Table 10. Statistics of fishers households' food sufficiency surveyed through PRA**

Food sufficiency	Status Numbers	Status %
a. Usually food deficit	215	79.63
b. Occasionally deficit	28	10.37
c. Break even	24	8.89
d. Surplus	3	1.11
<b>Total</b>	270	100.00

Around 75.56% of the fishers families surveyed consume fish every week, 21.85% most days ( $\geq 5$  days in a week), 2.59% at least every month and thus consuming 6891 kg fish annually. But if we consider 50g fish per capita daily the total demand of fish make a figure of 22320 kg annually and thus creating a short fall of fish as estimated to be 15429 kg annually (**Table 10**).

**Table 10. Fishers households' fish consumption frequency determined through PRA**

Frequency	Households (No)	Households (%)	Family members	Family members (%)	Consumption (Kg/yr)	Demand (Kg/yr)	Short fall (Kg/yr)
a. $\geq 5$ days in week	59	21.85	259	20.89	4403	4662	259
b. Every week	204	75.56	947	76.37	2462	17046	14584
c. At least every month	7	2.59	34	2.74	26	612	587
d. Seasonally	-	-	-	-	-	-	-
e. Rarely	-	-	-	-	-	-	-
<b>Total</b>	270	100.00	1240	100.00	6891	22320	15429

**Managerial information on the Kutirpara Primary Fishermen's Cooperative Society**

Overall ranking based on average mean score of cooperative management constraints faced in the survey through PI are detailed (**Table 11 and Table 12**). The top most important problems faced by the management are jute retting in the oxbow lake by jute farmers; lack of demarcation and more lease rent fixed on recorded area of the oxbow lake; poor socioeconomic conditions of fishers and lack of indigenous ornamental fish market to uplift fisherwomen; lack of cooperative storage, ice and processing plants for value addition and modern marketing and transport facilities while others important problems being complicated procedures for obtaining loan from the credit organization and high bank interest, water and energy charges; reluctant behaviors of bank personnel in advancing loan and lack of fish insurance coverage; lack of quality feed and manure and/or mill; natural calamity like drought; members not agreed for taking loan and aquaculture in purview of income tax; lack of effective supervision, skill, training and demonstration; short of operating capital and lack of credit in setting up of electric pump set; poaching of fishes; lack of technical knowledge/awareness on culture technology/good aquaculture practices (GAPs); lack of motivating agency; undue harassment by non-members in fishing and by police in transporting live fish; lack of quality fish seed stocking and other least important ones being lack of adequate water during summer and rain water harvesting and utilization; political conflicts among members; interference of anti-social elements; political interference from outsiders; lack of soil and water testing facility, limes (chemicals) /medicines supply; lack of organized and motivated manpower; price fluctuation, individual selling approach and low bargaining power resulting low prices of fish; non-availability of assured market, fishery inputs hubs, gear or craft manufacturing company; malpractices of middlemen; poisoning of fishes; natural calamity like flood; lack of coordination within cooperative structure and inadequate quantity of loan, subsidies and relief. Priority issues that were cropped up additionally during survey through PI are presented with top priority ranking for the Chhariganga oxbow lake's sustainable management (**Table 13**).

**Table 11. Constraints faced in management of cooperative society based on oxbow lake**

Constraints	Most important	Important	Least important	IS	MS	AMS	Ranking
1. Social constraints faced in management of cooperative society							
a. Jute retting in the oxbow lake by jute farmers	25	-	-	50	16.67	2.38	1
b. Poaching of fishes	12	13	-	37	12.33	1.76	2
c. Undue harassment by non-members in fishing and by police in transporting live fish	5	20	-	30	10.00	1.43	3
d. Interference of anti-social elements	1	5	19	7	2.33	0.33	4
e. Political interference from outsiders	2	1	22	5	1.67	0.24	5
f. Poisoning of fishes	-	1	24	1	0.33	0.05	6
g. Lack of coordination within cooperative structure	-	-	25	-	-	-	7

Constraints	Most important	Important	Least important	IS	MS	AMS	Ranking
Total	45	40	90	130	43.33	6.19	
2. Economic constraints faced in management of cooperative society							
a. Lack of demarcation and more lease rent fixed on recorded area of the oxbow lake	25	-	-	50	16.67	2.78	1
b. Complicated procedures for obtaining loan from the credit organization and high bank interest, water and energy charges	24	1	-	49	16.33	2.72	2
c. Reluctant behaviors of bank personnel in advancing loan and lack of fish insurance coverage	23	2	-	48	16.00	2.67	3
d. Members are not agreed for taking loan and Aquaculture in purview of Income tax	20	3	2	43	14.33	2.39	4
e. Short of operating capital and Lack of credit in setting up of electric pump set	12	13	-	37	12.33	2.06	5
f. Inadequate quantity of loan, subsidies and relief	-	-	25	-	-	-	6
Total	104	19	27	227	75.67	12.61	
3. Technical constraints faced in management of cooperative society							
a. Lack of quality feed and manure and/ or mill	21	4	-	46	15.33	3.07	1
b. Lack of technical knowledge / awareness on culture technology /Good Aquaculture Practices (GAPs)	12	10	2	34	11.33	2.27	2
c. Lack of quality fish seed stocking	10	9	6	29	9.67	1.93	3
d. Lack of adequate water during summer and rain water harvesting and utilization	4	5	16	13	4.33	0.87	4
e. Lack of soil and water testing facility, limes (chemicals) /medicines	-	3	22	3	1.00	0.20	5
Total	47	31	46	125	41.67	8.33	
4. Marketing constraints faced in management of cooperative society							
a. Lack of cooperative storage, ice and processing plants for value addition and modern marketing and transport facilities	25	-	-	50	16.67	4.17	1
b. Price fluctuation, Individual selling approach and Low bargaining power resulting low prices of fish	-	2	23	2	0.67	0.17	2
c. Non-availability of assured market, fishery inputs hubs, gear or craft manufacturing company	-	2	23	2	0.67	0.17	2
d. Mal practices of middlemen	-	1	24	1	0.33	0.08	3
Total	25	5	70	55	18.33	4.58	
5. General constraints faced in management of cooperative society							
a. Poor socio-economic conditions of	25	-	-	50	16.67	2.38	1

Constraints	Most important	Important	Least important	IS	MS	AMS	Ranking
fishers and lack of indigenous ornamental fish market to uplift fisherwomen							
b. Natural calamity like drought	20	5	-	45	15.00	2.14	2
c. Lack of effective supervision, skill, training and demonstration	15	9	1	39	13.00	1.86	3
d. Lack of motivating agency	12	8	5	32	10.67	1.52	4
e. Political conflicts among members	2	5	18	9	3.00	0.43	5
f. Lack of organized and motivated manpower	1	1	23	3	1.00	0.14	6
g. Natural calamity like flood	-	-	25	-	-	-	7
Total	75	28	72	178	59.33	8.48	

IS= Individual score, MS=Mean score (IS÷3), AMS=Average mean score (MS ÷ No of constraints considered)

Table 12. Overall ranking of cooperative management constraints faced in the survey through PI

Cooperative management constraints	Most important	Important	Least important	IS	MS	AMS	Ranking
1. Jute retting in the oxbow lake by jute farmers	25	-	-	50	16.67	0.57	1
2. Lack of demarcation and more lease rent fixed on recorded area of the oxbow lake	25	-	-	50	16.67	0.57	1
3. Poor socioeconomic conditions of fishers and lack of indigenous ornamental fish market to uplift fisherwomen	25	-	-	50	16.67	0.57	1
4. Lack of cooperative storage, ice and processing plants for value addition and modern marketing and transport facilities	25	-	-	50	16.67	0.57	1
5. Complicated procedures for obtaining loan from the credit organization and high bank interest, water and energy charges	24	1	-	49	16.33	0.56	2
6. Reluctant behaviors of bank personnel in advancing loan and lack of fish insurance coverage	23	2	-	48	16.00	0.55	3
7. Lack of quality feed and manure and/ or mill	21	4	-	46	15.33	0.53	4
8. Natural calamity like drought	20	5	-	45	15.00	0.52	5
9. Members are not agreed for taking loan and Aquaculture in purview of Income tax	20	3	2	43	14.33	0.49	6
10. Lack of effective supervision, skill, training and	15	9	1	39	13.00	0.45	7

Cooperative management constraints	Most important	Important	Least important	IS	MS	AMS	Ranking
demonstration							
11. Short of operating capital and lack of credit in setting up of electric pump set	12	13	-	37	12.33	0.43	8
12. Poaching of fishes	12	13	-	37	12.33	0.43	8
13. Lack of technical knowledge / awareness on culture technology /Good Aquaculture Practices (GAPs)	12	10	2	34	11.33	0.39	9
14. Lack of motivating agency	12	8	5	32	10.67	0.37	10
15. Undue harassment by non-members in fishing and by police in transporting live fish	5	20	-	30	10.00	0.34	11
16. Lack of quality fish seed stocking	10	9	6	29	9.67	0.33	12
17. Lack of adequate water during summer and rain water harvesting and utilization	4	5	16	13	4.33	0.15	13
18. Political conflicts among members	2	5	18	9	3.00	0.10	14
19. Interference of anti social elements	1	5	19	7	2.33	0.08	15
20. Political interference from outsiders	2	1	22	5	1.67	0.06	16
21. Lack of soil and water testing facility, limes (chemicals) /medicines supply	-	3	22	3	1.00	0.03	17
22. Lack of organized and motivated manpower	1	1	23	3	1.00	0.03	17
23. Price fluctuation, Individual selling approach and low bargaining power resulting low prices of fish	-	2	23	2	0.67	0.02	18
24. Non-availability of assured market, fishery inputs hubs, gear or craft manufacturing company	-	2	23	2	0.67	0.02	18
25. Malpractices of middlemen	-	1	24	1	0.33	0.01	19
26. Poisoning of fishes	-	1	24	1	0.33	0.01	19
27. Natural calamity like flood	-	-	25	0	0.00	0.00	20
28. Lack of coordination within cooperative structure	-	-	25	0	0.00	0.00	20
29. Inadequate quantity of loan, subsidies and relief	-	-	25	0	0.00	0.00	20

IS= Individual score, MS=Mean score (IS÷3), AMS=Average mean score (MS ÷ No of constraints considered for cooperative management)

Table 13. Priority issues cropped up during survey for sustainable management through PI

Priority issues for sustainable management	Mos t imp orta nt	Im po rta nt	Leas t imp orta nt	IS	MS	AMS	Ranking
1. Violation of motives of formation of PFCS and exclusive rights of public water bodies to fishers	25	-	-	50	16.67	1.11	1
2. Siltation leads to less water retention capacity of lake and flood	25	-	-	50	16.67	1.11	1
3. Non-demarcation expedites conversion of public water body into private agriculture land properties by reducing EWSA	25	-	-	50	16.67	1.11	1
4. Drought makes more conversion from water body to agriculture fields (for Boro cultivation) by reducing lake's EWSA	20	5	-	45	15.00	1.00	2
5. Major fish catch by non fishers during monsoon making catch left less available to fishers members in rest of a year	12	13	-	37	12.33	0.82	3
6. Members think bank loan as nonrefundable subsidy which makes PFCS management more economically backward	12	13	-	37	12.33	0.82	3
7. Need of training to BODs and/or members of PFCS	12	10	2	34	11.33	0.76	4
8. Water lift by both bank side agriculture farmers reduces water depth and makes more expanded agriculture land. And fishing by them with modern nets during monsoon in those encroached areas, eventually fishers members can't compete with them	3	20	-	26	8.67	0.58	5
9. Non availability of fish round the year leads to shift of professions (by acting as only fishers for 4 months and agriculture labour or simple labour for rest of the year)	3	10	12	16	5.33	0.36	6
10. Fishers members expecting the government helps or inputs only but not maintaining them properly	1	7	17	9	3.00	0.20	7
11. Little/no attention to look after the once rich indigenous fish from extinction by adopting no proper management policies	1	6	18	8	2.67	0.18	8
12. Non fishers dominance in BODs for PFCS functioning reduces management efficiency by mooted political agenda rather than developmental issues	2	1	22	5	1.67	0.11	9
13. Third party entry in obtaining willful or forceful sublease from PFCS taking public water bodies on lease by paying nominal rent	2	1	22	5	1.67	0.11	9
14. Lack of inspection and monitoring leads to fake PFCS registered in favour of some non fishers obtaining public water, subsidies, inputs or help for no virtual possession of water	1	2	22	4	1.33	0.09	10
15. Official documents rather rest in pockets of some BODs members than in office of some of the PFCSs	1	1	23	3	1.00	0.07	11
Total	145	89	138	379	126.33	8.42	11

IS= Individual score, MS=Mean score (IS÷3), AMS=Average mean score (MS ÷ No of priority issues considered for sustainable management)

Overall ranking based on total average mean scores of the importance values of major topics kept before the fishers respondents for discussion through PI were furnished in the whole socioeconomic survey (Table 14). Fishers found their knowledge about degree of danger in different management practices in oxbow lake ecosystem as the most important topic of their concern. The least important one was marketing constraints faced in management of cooperative society.

Table 14. Overall ranking of importance values of major issues kept for discussion in the survey

Major topics of the socioeconomic survey (How far concerned for them)	Most import ant	Imp orta nt	Least importa nt	TIS	TMS	TAMS	Ranking
1. Knowledge about degree of danger in different management practices in oxbow lake ecosystem*	172	17	36	361	120.33	13.37	1
2. Economic constraints faced in management of cooperative society	104	19	27	227	75.67	12.61	2
3. Knowledge of Management Benefits from oxbow lake ecosystem*	130	35	59	295	98.33	10.93	3
4. Knowledge of oxbow lake ecosystem and its management*	207	124	143	538	179.33	9.44	4
5. General constraints faced in management of cooperative society	75	28	72	178	59.33	8.48	5
6. Ecological Changes taken place during last 30 years*	175	157	168	507	169.33	8.45	6
7. Priority issues cropped up during survey for oxbow lake's Sustainable management	145	89	138	379	126.33	8.42	7
8. Technical constraints faced in management of cooperative society	47	31	46	125	41.67	8.33	8
9. Social constraints faced in management of cooperative society	45	40	90	130	43.33	6.19	9
10. Marketing constraints faced in management of cooperative society	25	5	70	55	18.33	4.58	10
Total	1100	520	849	2720	906.67	90.35	10

TIS= Total of individual scores, TMS=Total of mean scores (TIS÷3), TAMS=Total of average mean scores (TMS ÷ No of major topics), \* Ghosh and Biswas (2016)

## DISCUSSIONS

Fishers in and around the oxbow lake ecosystem under present study were surveyed to be mostly with education level of below or up to primary level. Present findings on their education level are in full or partial agreement with other similar studies (Baruah *et al.*, 2000; Peixer and Petrere, 2009; Biswasroy *et al.*, 2011; Kostori, 2012; Abdullah-Bin-Farid *et al.*, 2013; Siddiq *et al.*, 2013; Zahan, 2013). Non availability of fish round the year leads fishers to shift of their professions. Changed climate and declining fish stock among many other important factors influence fishing profession and people were found to be more interested in agriculture, fishing compared to other occupations (Biswasroy *et al.*, 2011; Roy *et al.*, 2012). Present findings on fishers' profession are in full or partial agreement with other varied studies for the fisher community in oxbow lake ecosystems (Rahman *et al.*, 1999; Baruah *et al.*, 2000; Ahmed *et al.*, 2005; Biswasroy *et al.*, 2011; Kostori, 2012; Siddiq *et al.*, 2013; Zahan, 2013). Fishers are among the poorest sections of the society living in different aquatic ecosystems. The living standard of fishers in the present study has been observed to be very low like other studies (Kostori, 2012; Zahan, 2013; Abdullah-Bin-Farid *et al.*, 2013) except concrete/tin (expensive) roof houses for all fishers as we find in the Chhariganga oxbow lake ecosystem. Present findings on assessment of fishers' land holding capacities also corroborate fully or partially with the similar studies (Baruah *et al.*, 2000; Abdullah-Bin-Farid *et al.*, 2013). However, water area under the possession of number of fishermen remains unutilized due to so many various factors as observed in present study including family rivalry and non-cooperative attitude among fishers (Bhaumik, 1997).

Different constraints were found based on the importance of fishers on Chhariganga oxbow lake ecosystem. The followings were the most important priority issues evolved during socioeconomic survey and ranked based on average mean scores that need immediate attention for oxbow lake's sustainable management: jute retting in the oxbow lake

by jute farmers; lack of demarcation and more lease rent fixed on recorded area of the oxbow lake; lack of cooperative storage, ice and processing plants for value addition and modern marketing and transport facilities; complicated procedures for obtaining loan from the credit organization and high bank interest, water and energy charges and poor socioeconomic conditions of fishers and lack of indigenous ornamental fish market to uplift fisherwomen.

The present findings on different constraints faced by the fishers and their cooperative society are in full or partial agreement with various other studies. The unawareness of technical knowhow is found in present study as an important problem for fish farmers like other study (Bhaumik *et al.*, 1991). We too observed that ignorance of fish farmers about developed aquaculture technology, lack of quality fish seed and unavailability of implements required while gear and crafts as the major constraints causing problems to fish farmers like other studies (Bhaumik *et al.*, 1991; Choudhary *et al.*, 2001; Nair *et al.*, 2007). The absence of effective management is found in present study as the major constraint of fishery cooperative society like other study (Annamalai, 1996). Lack of effective supervision, lack of motivating agency, proper supervision by the board of directors of the society, awareness training program and cooperative education training are also the major suggestions offered by the society members in the present study for strengthening and improvement of fishermen cooperative societies like other study too (Sau *et al.*, 2012). The proper marketing facility and storage facility for harvested fish within easy reach of the fishermen covering a number of cooperatives or group can provide viable fishing strategies. This finding of the present study was in full agreement with other study (Datta and Kundu, 2007). Most important marketing and technical constraints included the non-availability of assured market and lack of water during summer and lack of soil and water testing facilities (Sau *et al.*, 2012). The low availability of provision of loan at reasonable interest rate, little interest in taking loan followed by poverty (Choudhary *et al.*, 2001; Sau *et al.*, 2012) and lack of quality fish products for market are also observed to be major constraints of fisheries cooperative management and fishers (Upare, 1996). The social constraints were found as the highest intensity with undue harassment by non-members, poaching of fishes and lack of coordination within cooperative structure as perceived by the fishers (Sau *et al.*, 2012).

To address lacuna for achieving sustainability in oxbow lake ecosystem, the important priority issues that cropped up during socioeconomic survey were ranked based on average mean scores. The following issues need to be addressed with utmost care and immediate attention for oxbow lake's sustainable management: (1) There should not be any violation of motives of formation of Kutirpara primary fishermen's cooperative society limited (KPFCS) for proper management of public water bodies by the fishers community and there should be exclusive rights of public or vested water bodies to fishers only (2) As siltation leads to less water retention capacity of lake and flood, there is urgent need to renovation of the oxbow lake (3) As non-demarcation expedites the conversion of public water body into agriculture land properties by private players by reducing effective water spread area (EWSA), there is urgent need to demarcate the oxbow lake area to keep its original recorded area (4) As drought makes more conversion from water body to agriculture fields (for Boro cultivation) by reducing EWSA, there should be water control mechanisms like sluice gate etc. for regulation and channelizing the water flow from the Ganga River into the semi-closed oxbow lake (5) As major fish catch caught by non-fishers members during monsoon reduces the catch of the fisher members in rest of a year, there should be strict fishing regulation and management in the oxbow lake (6) As members think public loan as nonrefundable subsidy which makes PFCS management more economically backward, the attitude of the fisher members should be changed through proper training for improving repayment and consequently credit flow to the members and their cooperative management to avoid borrowing from the dishonest money lenders (7) There is need of imparting regular training to board of directors (BODs) and/or members of KPFCS in latest techniques and issues for sustainable fisheries management (8) As water lift by both bank side agriculture farmers reduces water depth and expands more agriculture land and fishers members as weaker section can't compete and/or afford eventually with the farmers fishing in the encroached areas with modern nets during monsoon, there should be urgent intervention to reduce the completion to a rational balance between fishery and agriculture through cooperation and consultation with local community (9) As non-availability of fish round the year leads to shifting of professions of the fisher members (by acting as only fishers for 4 months and agriculture labour or simple labour for rest of the year), there is need to promote aquaculture in the oxbow lake through public private partnership (PPP) mode and also to make alternate viable livelihood generation during lean periods for the fisher members including older and infirm fishers (10) The fisher members should be trained properly to change in their attitude of expecting only government's helps or inputs, keeping the received inputs up properly to become self-reliant (11) As little or no attention to look after the once rich

indigenous fish species from extinction, there is urgent need to rehabilitate those fish species by adopting proper management policies (12) As the dominance of non-fishers in the board of directors (BODs) for PFCS functioning reduces management efficiency by mooted political agenda rather than developmental issues, there should be strict prohibition of such entry into the managing committee of PFCS for its proper functioning (13) There should be strict monitoring to ensure that there is no third party entry in obtaining willful or forceful sublease from the PFCS which take public water bodies on lease by paying nominal rent (14) There should be frequent inspection and monitoring to prevent from obtaining public water, subsidies, inputs or helps by fake PFCS registered in favour of some non fishers without any virtual possession of water to enable the actual PFCS to get public helps (15) Regular supervision and inspection should be in place to keep PFCS's official documents in its office itself or in custody of authorized person (s).

### Strategies and prioritization of interventions

The broad aspects of interventions needed to improve the socioeconomic conditions of the oxbow lake ecosystem for sustainable management are as follows:

1. Restoration and development of the oxbow lake environment through interventions like de-silting, demarcating; macrophyte management through biological and manual control measures potentially through employment guarantee programme, and its proper utilization through production of organic manures and vegetables; mass awareness on policies, rules, regulations, government and NGOs' role on regulating water lifting, jute retting intensity and density, and indiscriminate uses of fishing gears with varying mesh sizes, observing fishing close season and chemicals and pesticides
2. Setting up of cooperative storage and marketing facilities, and fish feed production unit at least at district level, availability of adequate and timely credit through formal models, alternate credit delivery mechanisms for facilitating small fish fishermen and cooperative societies to avail credit with promotion of attractive insurance scheme
3. Maintenance of genetic resources by cryopreservation of germplasm, breeding of indigenous fishes, setting up fish hatcheries under both public or private sector and adequate awareness creation among hatchery operators to follow breeding protocol and establishing of diagnostic centres for detection of fish diseases and rehabilitation of endangered species through ranching; promotion of ecological, integrated and/or organic aquaculture through pen culture, for increasing the productivity of fish in oxbow lakes in the district in particular and in the state in general from its present level through training and capacity building of fish fishermen on scientific organic fish farming through integrated farming for sustainable farming leading to higher production at lower cost and through diversification of species and culture technologies.
4. Making fish inventory and monitoring and promotion of ecotourism in all oxbow lakes in Nadia

### CONCLUSION

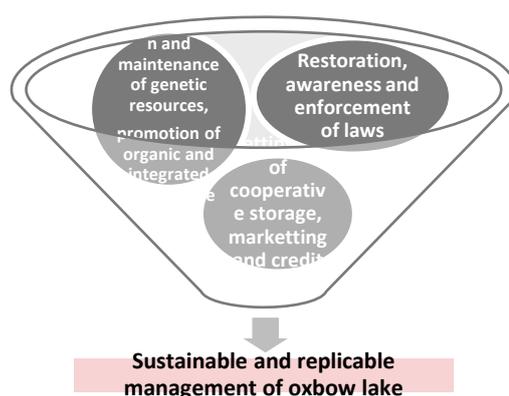


Figure 2: Proposed interventions for sustainable and replicable management of oxbow lake

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